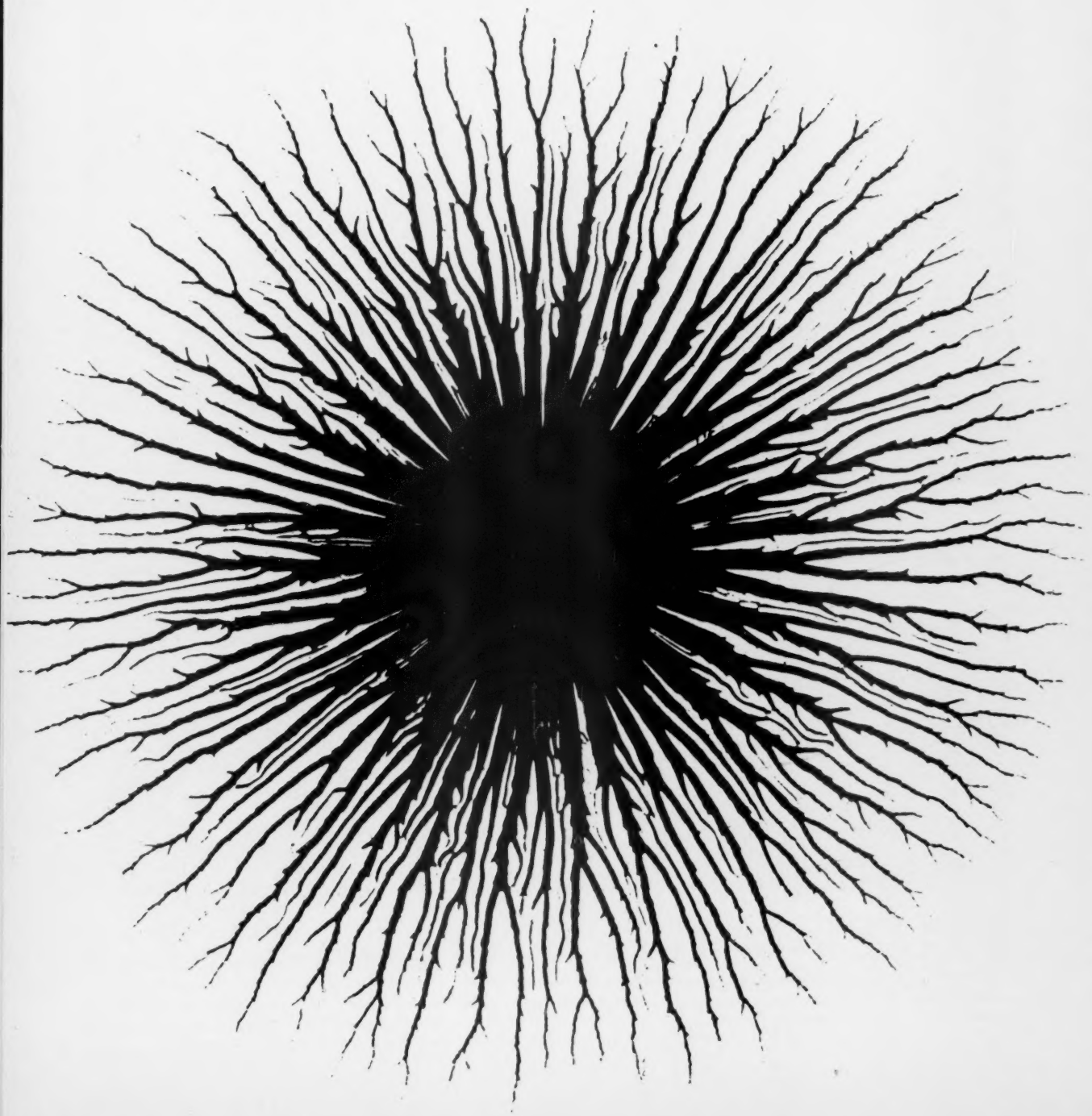
february 1954

tech engineering news



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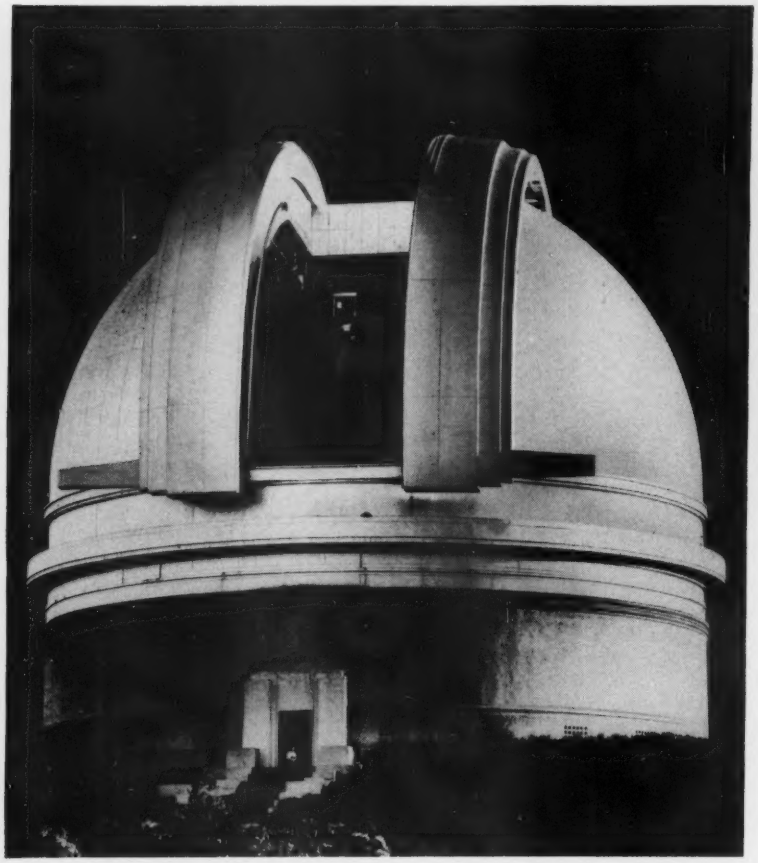

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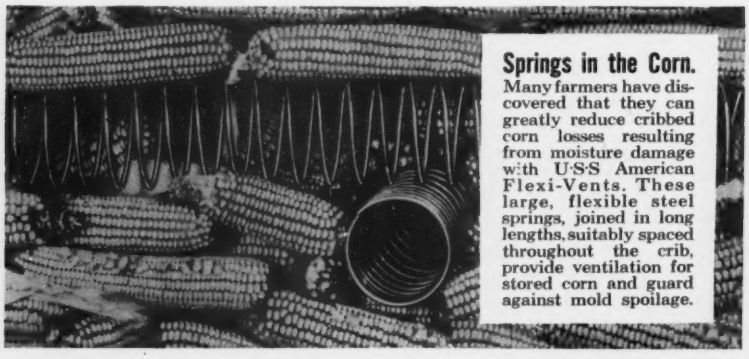

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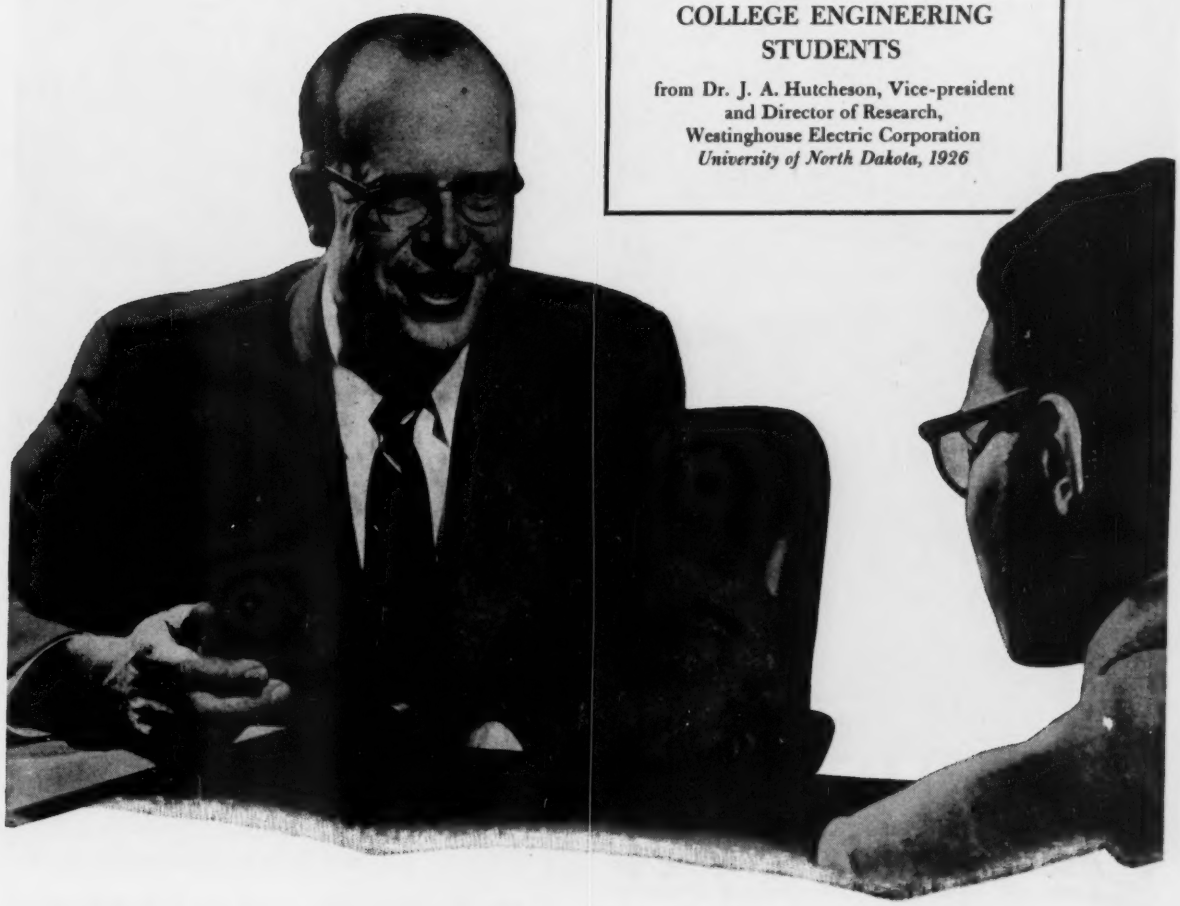
A MESSAGE TO COLLEGE ENGINEERING STUDENTS

from Dr. J. A. Hutcheson, Vice-president and Director of Research, Westinghouse Electric Corporation
University of North Dakota, 1926



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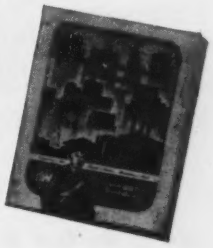

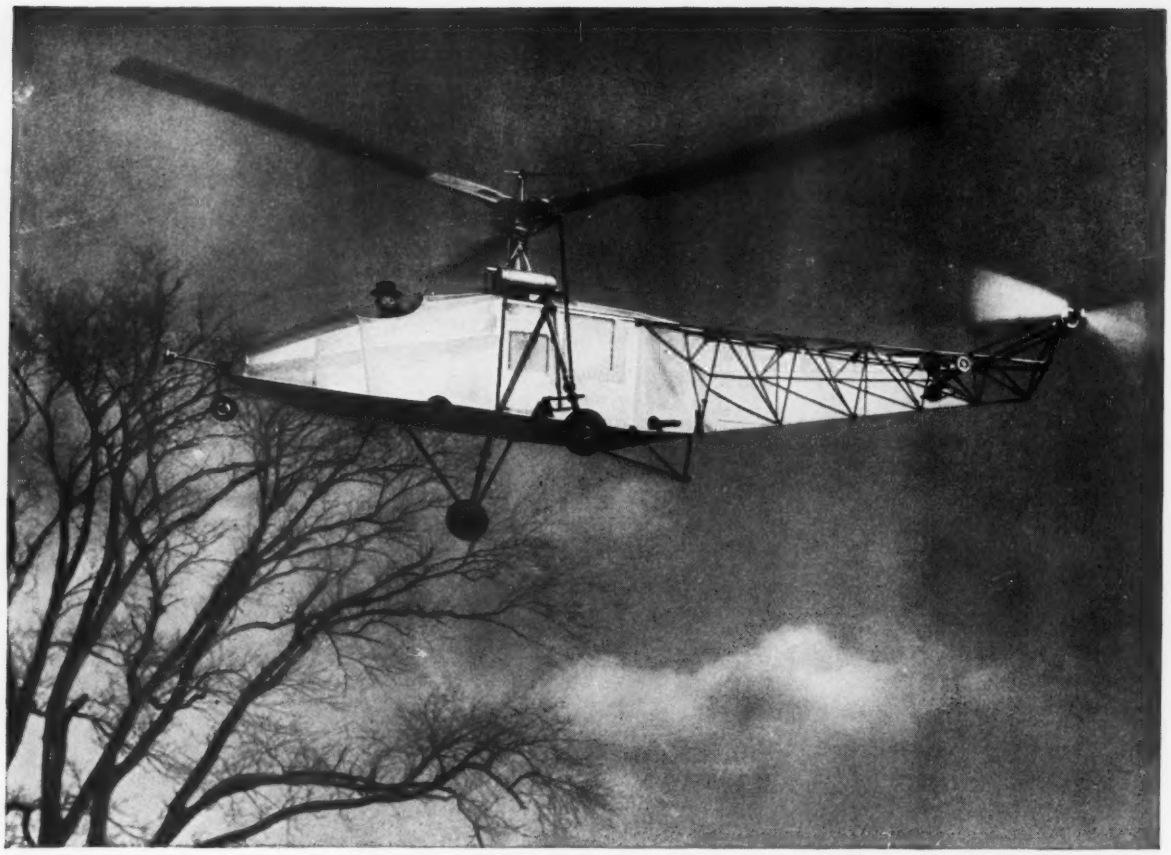

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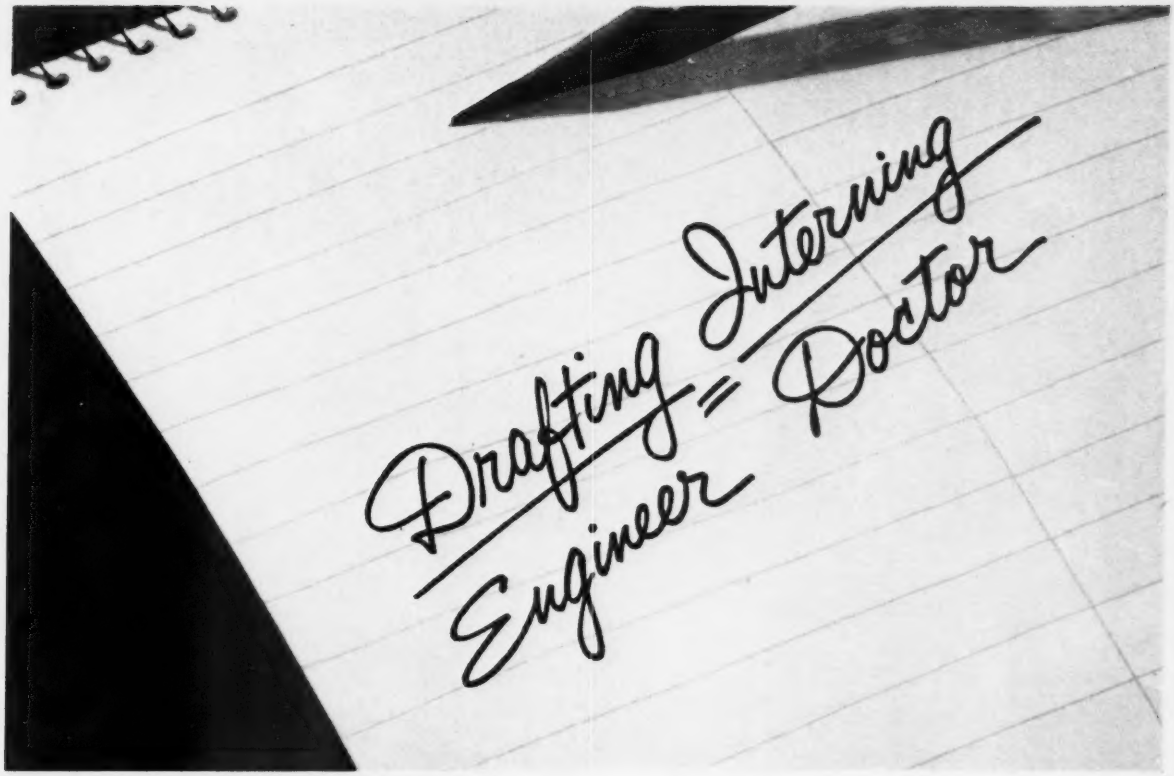

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FRONTISPIECE

Свет

Published monthly during the school year at Walker Memorial, Cambridge 39, Massachusetts, by the undergraduates of the Massachusetts Institute of Technology. Entered as second class matter, at the Post Office, June 1, 1920, at Boston, Massachusetts under the Act of March 3, 1879. Copyright 1954 by The Tech Engineering News. Subscription per year $1.75. Foreign $2.50. One copy 25 cents.

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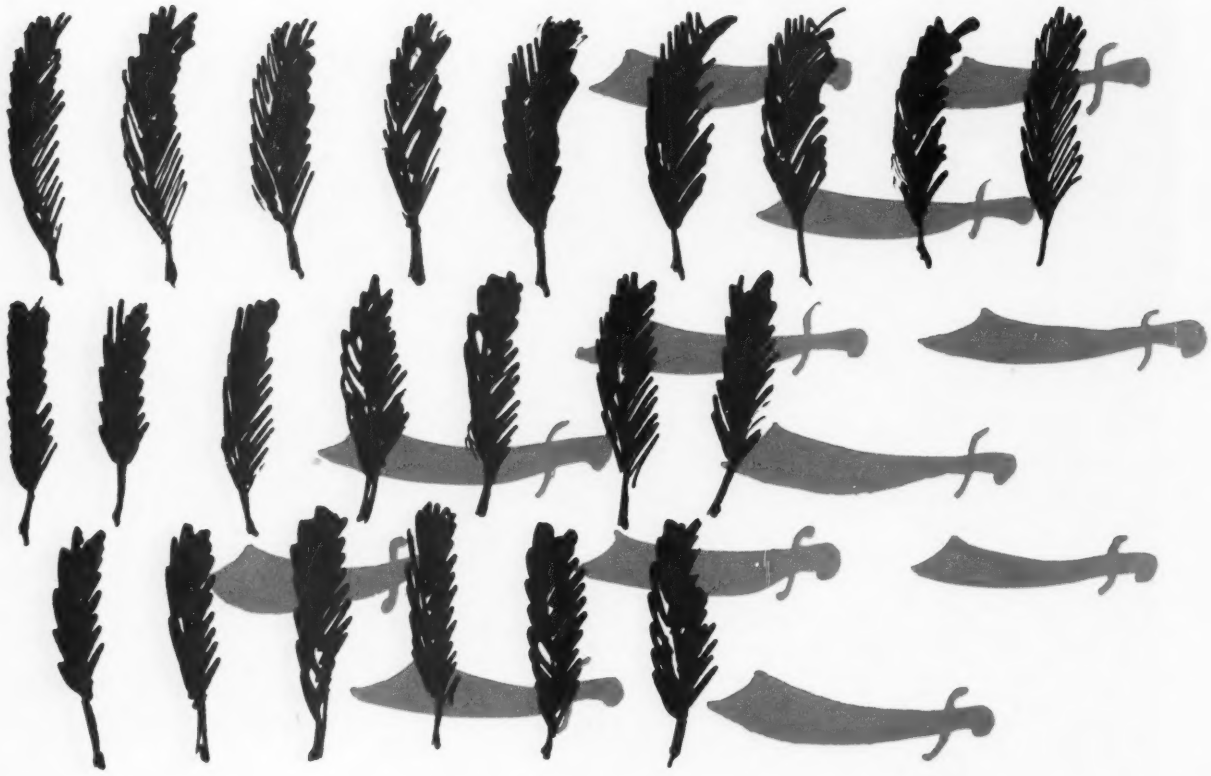
universal military training

By Richard Day, G.



Universal Military Training will be considered by Congress during its present session. UMT poses a problem for all physically and mentally fit young men reaching their eighteenth birthdays. Indirectly or directly its effect would influence the many facets of our national life.

Before considering the proposed UMT, it would be well to examine some of the proposals made in the past, but which have not been enacted. A bill put forth last year would establish an armed forces training program geared to utilize fully the existing plants and facilities of schools and colleges through the creation and maintenance of a "Students' Armed Forces Training Corps." Other proposals asked for the establishment of a "National Security Training Commission" to supervise a "National Security Training Corps" consisting of every male high school student in the United States. Corps service would have meant being in a unit for not less than two academic years as well as some additional summer camp training periods.

The present UMT proposal resembles those advanced in the past, and which received serious consideration from Congress. This plan would conscript all eighteen-year-olds with the exception of those reaching that age before January, 1956. On his eighteenth birthday a youth would draw lots to see if he goes with the regular "service" pool or into the "training" pool.

If he goes into the "service" pool, his course will be very much like that followed today. If, before his call comes, he has signed up for college Reserve Officers' Training Corps and agreed to serve two years on active duty, he will be deferred until he has graduated and received his commission. This is much like the present system.

However, if he draws a "service" assignment under the new plan, he will not be allowed to get a series of deferments even to finish a college science course. The present system does allow that.

On the other hand, if a youth draws a "training" assignment, his military career will be entirely different from that of a man getting the "service" assignment. He will have to pick a month, within limits of course, when he wants to be inducted for training. He will be allowed to finish high school or a school year of college, if

engaged in either. His pay will be about $30 a month. The National Security Training Commission—not the Army—will supervise his course.

After six months of basic training, the trainee will owe *seven and one-half years* of service in the "Ready Reserve." He must appear for active duty on 30 days' notice. By contrast the draftee will spend only one year in the Ready Reserve if he so chooses, after two years of active service. Only one boy in six of those reaching eighteen would go into the "training" program for the first few years. The remainder would be taken into the "service" or be rejected on account of physical or mental shortcomings.

Trainees would receive no veterans' benefits whereas the veteran of two years service would be eligible for the usual GI rights—educational aid, home loans, insurance, hospitalization, etc.

In many respects there is a great deal of similarity between the proposed UMT bill and the present draft laws which are effective until 1955. The two laws now governing the future of young able bodied men are the Universal Military Training and Service Act of 1951, and the Armed Forces Reserve Act of 1952. UMTS (the former) provides for the selective service induction of men for two years of training and active service, and for an eight year military obligation on men initially entering the Armed Forces after June 19, 1951. This means six additional years of military obligation for those serving two years. The Reserve Act provides for the assignment of reservists to mobilization categories and to the mobilization of components.

Why UMT Should Be Accepted

The most important reason advanced for the accepting of UMT is that it will better provide for the national defense. In the face of the potential danger of war with Soviet Russia and her satellites a strong war machine which can be readily brought into use on a short notice is held by military experts to be absolutely necessary.

It is maintained that UMT will eliminate some of the glaring inequalities of the present draft system. Under the present system many young men who had previously served as soldiers overseas were forced to don the uniform and fight once more in Korea, while many younger men, who contrived the right sequence of deferments for education, marriage, and employment escaped service altogether.

Segregation along racial lines is now definitely on the way out in the regular armed forces. There are now no all-colored units in the Navy or in the Air Force, and 95% of the colored men in the Army are in units containing white men. If this is carried over into the UMT Corps, tolerance and understanding between the racial troops may be increased.

Earl D. Johnson, Under Secretary of the Army, states that it is not possible to predict the effects of UMT on education, on the educational institutions, or on the individual involved. He maintains that at the present, the Army is operating the largest school and college program in the world which emphasizes the dignity of the individual and that UMT would help the Army achieve a major goal.

As one might suspect the strongest support for UMT comes from military or semi-military groups like the National Guard Association, the Reserve Officers' Association, and the American Legion. Very few other groups actively support it or have supported measures like it in the past.

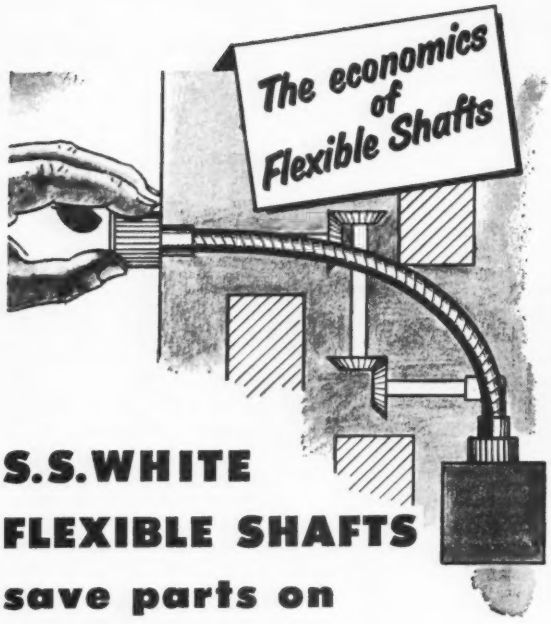
Why It Should Not Be Accepted

Instead of adding to the armed might of this country, UMT might seriously detract from it. Since the men put into the "training" program would not be available for service barring a national emergency, there would be a reduction in the number of troops actually on hand at any one time. In addition the number of officers for the regular Army would be reduced because of the number actually involved in the training program. Maj. Gen. John S. Wood, U. S. A., retired, is quoted in the *New York Times*, February 15, 1952, as saying that "from the stand point of national security—which should be the only basis of consideration—UMT as now planned will cost enormous sums of money without providing any security whatever or in any way deterring possible aggressors." Although this statement was made about the proposed UMT law of 1952, it applies equally well to the bill proposed now which essentially is the same.

John A. Hannah, Assistant Secretary of Defense, stated during a recent interview (*U. S. News and World Report*, Oct. 16, 1953) that he would not recommend a change in the present system toward Universal Military Training. Further he says that "so long as we are going to need at least two years of service from all young men, then there can be no enthusiasm on the part of the Defense Department for the UMT program which contemplates training them for a short period and releasing them to civilian life."

Men trained in the UMT program would not be readily available for immediate service in event of the outbreak of a hot war. It is impossible to stockpile the trainees so that they would be available at any time. The technology of modern warfare constantly changes rapidly making equipment and methods obsolete. To expect the men to remember any but the smallest fraction of the information and techniques handed out to them after a period of even six months is illogical. Hanson Baldwin (*The New York Times*, Feb. 15, 1952) is of the opinion that the drafting and training of the men for war is not the major problem, but that the real problem of mobilization is the manufacture of arms and equipment and the organization of units.

The nature of the modern war must be considered inasmuch as UMT is to provide military protection. In the case of aerial attack by bombers carrying atomic bombs, the only men who could be effective militarily would be those already trained and located at their bases ready for action. In carrying through such a war highly skilled and trained technicians in the fields of electronics, aeronautics, engineering, pharmacy and many others would have to be available. There is little reason to believe that such could be provided in six months of training followed by seven and one-



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half years of reserves with infrequent training periods.

It has often been claimed that UMT would reduce casualties in warfare. Proponents of a permanent system of conscription for this country maintain that UMT gives a soldier a better-than-average chance to survive in battle. Official Army studies, as reported by the *Infantry Journal* in September 1949, show that there is nothing to the claim that trained soldiers have less chance of getting hit than untrained men. According to this professional army magazine the greatest number of casualties are caused by fragments from high explosive shells, which do not discriminate between trained and untrained troups. The *Infantry Journal* states: "No factual data exists to support the universally held opinion that the infantry replacement has initially a higher casualty rate than the veteran." In other words there is no reason to believe that military training will reduce the number of casualties.

The cost of UMT must be considered since tens of billions of dollars annually are being paid out for past wars, present police actions, and future holocausts. The actual cost of UMT is, of course, not known exactly and estimates vary considerably. If implemented, its cost would probably be no less than the estimate made by the National Security Training Commission in October, 1951. The cost of the UMT program proposed then was estimated as being about $4 billion for the first year and $2 billion each year thereafter. In contrast to this sum required for the training of less than a million men, the cost of the nation's public elementary and secondary schools enrolling 25,000,000 as $4.7 billion for the school year 1949-50. Since estimates of costs are not infrequently much too modest and since we may not have reached the top of the inflationary trend, the actual cost might be considerably higher.

The cost of UMT may be regarded from the standpoint of the time required of each trainee. Although only six months would be spent initially in training, it could well result in a man's wasting additional months waiting to be inducted—unable to take a job or start into college because of the uncertainty of his date of induction. After his release he would have a period of waiting for a job or a new term of school to start. There is a faint possibility that the programs could be timed to mesh with the college terms, but as it now stands, waste of time would be inevitable.

It has been claimed that military training and service improved the health of the nation. There is no reason to suppose that UMT would depart drastically from the patterns maintained in the present Armed Forces. In spite of the fact that only the physically and mentally fit are admitted to the various branches of the Army, the incidence of mental illness, physical diseases, and rates of suicide are much higher than in the civilian population. If the UMT program were set up so that the health of the trainees were improved by it, those who actually need medical and psychiatric care would not benefit since they would not be admitted to the program. The time to protect and build-up the health and well-being of anyone is during his formative years rather than during early maturity.

The Armed Forces have never been noted for the improvement of morals of the men in them. By its very nature the Army must be authoritarian; initiative is not a quality appreciated by the drill sergeant. Robert M. Hutchins, former Chancellor of the University of Chicago, has this to say:

> Under military discipline the individual's chance to make free choices almost disappears. Somebody tells him what to do every minute of the day, and the first lesson the private learns is "never volunteer."
>
> I was in the army from the age of 18 to the age of 20 and cannot recommend it as a school of responsible citizenship. I came out lazier and more negligent than when I went in. I became an expert at cutting corners and at the elaborate kind of cheating to which privates devote most of their time.
>
> I think it stands to reason that, though free and independent citizens make the best army, the army is not the best place to make free and independent citizens.
>
> *Chicago Daily News,* May 8, 1951.

The environs of military bases and training camps often contain a higher than average concentration of gambling dens, houses of prostitution, "night clubs," and other institutions which have never received any great credit for improving the morals of anyone anywhere. There exist no adequate guarantees that incidents such as Biloxi will not be repeated again. It may be possible that a young man raised in the slums and coming from a broken home would be benefitted by the discipline which he would be under on duty and would also find the milieu of the army camp stimulating, but it almost certainly would not better the mind or morals of the average youth.

It is often pointed out that making *permanent conscription* a part of the American pattern of life may be a very dangerous step toward the militarization of this country. Although the Army may be more democratic in a few things such as racial relations than the average community, it does not then follow that, because the discipline, dirt, and training falls equally on all trainees, the system is democratic. The Army is set up as rigid caste system in which the men of lower rank have no voice in choosing or removing the officers above them, or changing the rules controlling their lives, or bettering conditions under which they must serve. In the past this country has accepted the military system during wars; accepting a *permanent* system of conscription to train men is an entirely different matter.

Building up a large permanent military caste is very apt to be the result of a permanent large-scale military program. In 1945, the last year of the war, there were 397 admirals and generals in the Pentagon and a Senate subcommittee found that there were 361 in 1951! One might well wonder why all the brass remained even though the Armed Forces in 1951 were much smaller than that of 1945. It is only natural that men who have attained high rank would like to maintain their position, pay and other benefits accruing from their rank, and would not be wholeheartedly in favor of a program involving reduction of arms and armies. These men would tend to be in favor of a measure such as UMT which more or less guarantees their position. This is borne out by the fact that military or semimilitary organizations support UMT. However, individuals within these organizations may be strongly opposed to the measure.

Alternative Programs

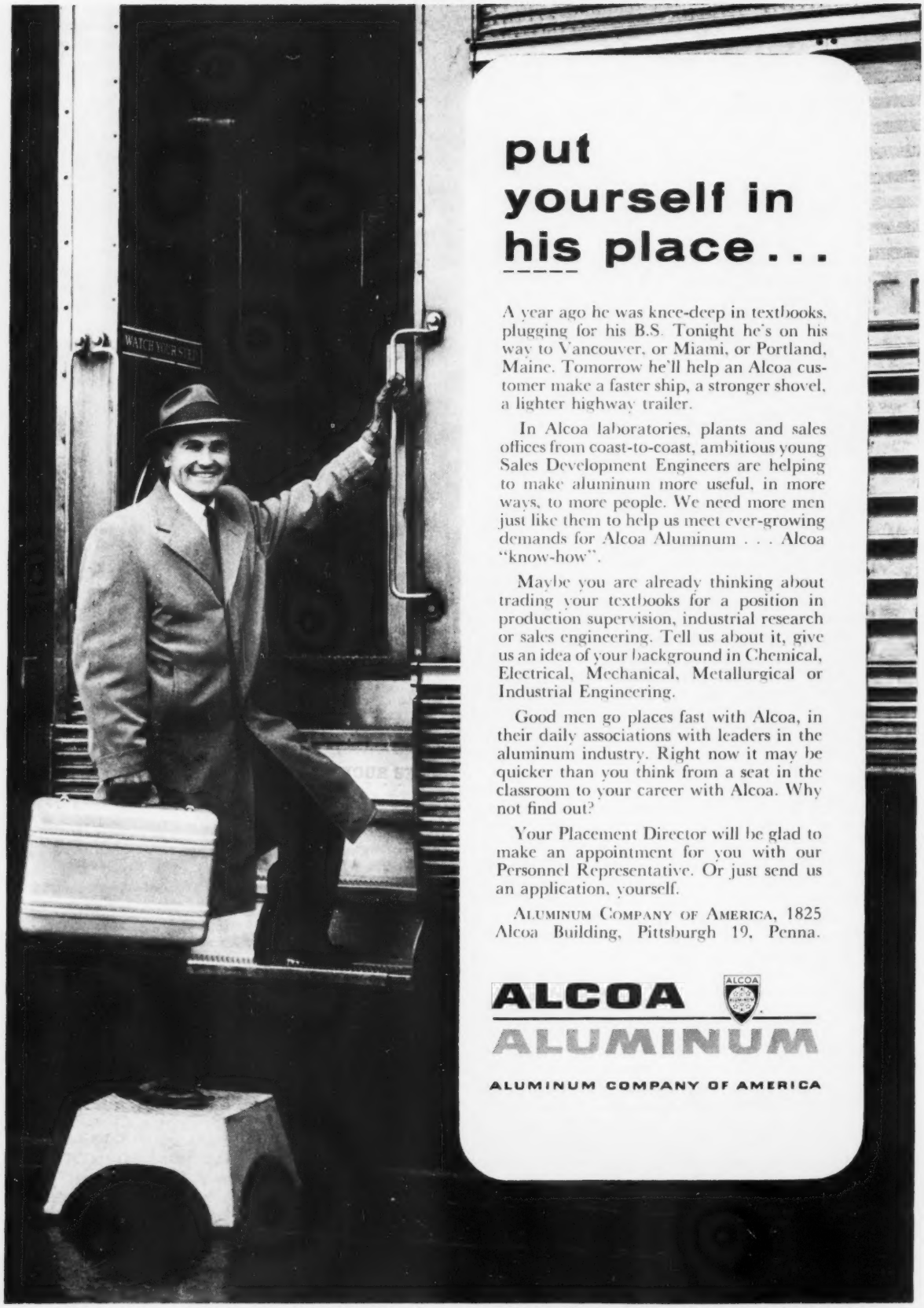
There can be no doubt that Communism backed up by Soviet Russia presents a very real danger to free peoples of the world. Nor can there be any doubt that a positive program must be followed by this and other free nations if the tide of Communism is to be stemmed.

The establishment of a supranational organization with real powers to eliminate armies, to remove intelligently those economic and educational differences which stimulate conflict, and in every way to bring order to the world is desirable. Modern technology makes 20th century New York as close to Moscow as 18th century London was to Paris. Instead of millions for the U. N. and similar organizations and billions for arms, much more lasting worth would be done if it were billions for international cooperation and millions for arms.

It is well known that Communism makes little progress in countries which have peace and economic stability. War-torn, famine-stricken China administered by inefficient and often corrupt men was easy prey for Communist propaganda. A man living on the starvation level may not be swayed as easily by promises of freedom as he is by promises of bread. While the building of schools and hospitals in Egypt will bring no cash returns, it will more than repay the investor in terms of world stability and increased productivity of the blighted area.

Militarism can be used only if one believes that the ends justify the means. This country became involved in World War II believing that by the hellish process of war we would gain more than would be lost. In thinking about UMT and the implications of fastening a permanent system of conscription for military service on this country, it would be well to keep in mind the words of the eminent historian, Arnold Toynbee:

> "Militarism . . . has been by far the commonest cause of the breakdown of civilization during the last four or five millennia which have witnessed the score or so of breakdowns that are on record up to the present date. Militarism breaks civilizations down by causing the local states into which the society is articulated to collide with one another in destructive fratricidal conflicts. In this suicidal process the entire social fabric becomes fuel to feed the devouring flame in the brazen bosom of Moloch."
>
> (from *A Study of History,* [Abridgement of Volumes I-VI by D. C. Somervell] by Arnold J. Toynbee, p. 190.) New York: Oxford University Press, 1947.



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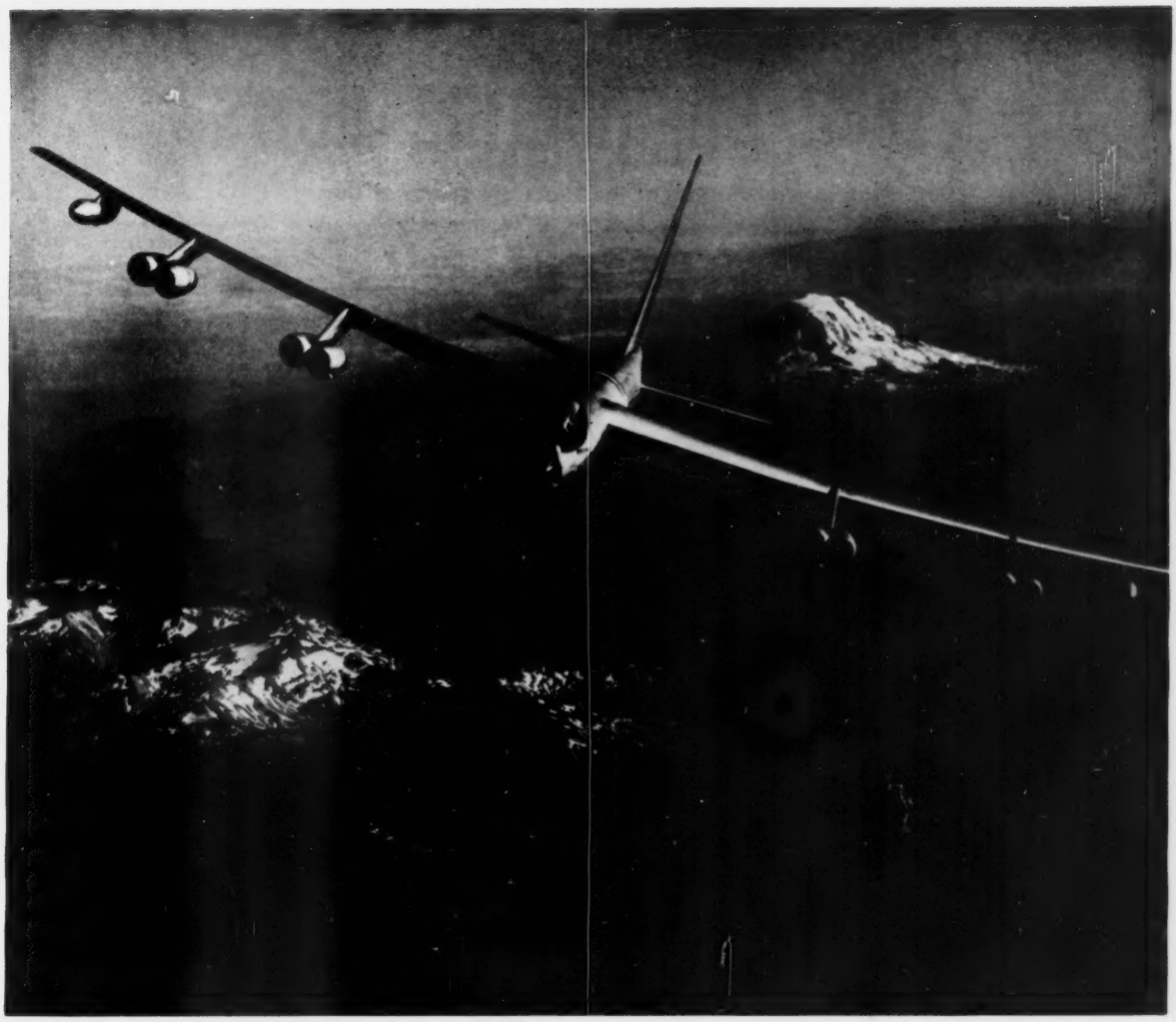

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from the editor's notebook

SIC Transit System

As members of the student body of M.I.T., we have occasion to ride on the so-called mass transportation system of this collection of towns known as a metropolitan area. We hear that the system continually costs the taxpayers more and more money; yet we know the fares have been raised twice in the last five years. We may well question what efforts this system, the MTA, is doing to increase its patronage and just where is it wasting what money it has.

We have noticed over the past few years that the MTA is "modernizing" by replacing streetcars with buses. This may be commendable, despite the fact that a high level officer of the MTA has informed one of our staff members that both buses and trackless trolleys actually cost more to operate than the trolleys that they have replaced, at least on a passenger-mile basis. Our observation, however, is that any MTA surface vehicle spends most of the rush hours sitting on the streets not moving anywhere because of the snarl of traffic. We cannot see any sense in the MTA's buying of *any* new surface transit vehicles of any type while the bulk of the rolling stock that does carry the majority of passengers is entirely out-dated. Boston operates the most obsolete rapid-transit cars of any American city. Yet any of these obsolete rapid-transit cars could be modernized into silent, efficient, comfortable vehicles with a fraction of the cost of one new bus or trackless trolley. The same can be said for the older type of trolley car operated in the trolley subway during rush hours. Far more people would benefit from such a program than from the present surface "modernization".

Often this "modernization" has the effect of driving the MTA's customers away in droves. A South Boston resident once was able to catch a modern streetcar at the nearest corner along Broadway and get a seat if he lived on the outer end of the line; this car would enter the subway for a fast trip through the downtown area to North Station. Now he will walk, unless the weather is terrible—and then the chances of a bus showing up are small indeed; his alternative is to ride a bus to one of two rapid-transit stations where he may, if he waits, ride a rail car already overloaded with people from Dorchester or Egleston. He walks.

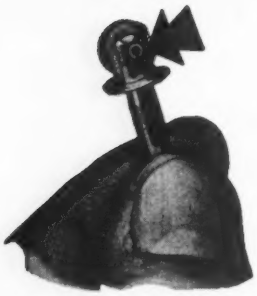
Of course, why should we complain? The abandonment of this modern, fast, surface-rapid-transit line has provided the TEN staff with free MTA transportation returning from our favorite Greek restaurant. Information on this situation will be gladly given to anyone applying at the TEN office.

D. F. S.

In this issue

John Wells writes the sequel to his summary of the NBS-MIT AD-X2 controversy. If you remember, TEN published his article last spring on the very day that the bubble broke and Allen V. Astin, the director of NBS, was fired. Our literary associate, **Karl Ludvigsen,** comes out with more of the hot poop about the latest in sport cars. He has written so much thus far that we have decided to let him write a regular monthly column, *Turning Over a New Wheel.* And **Malcolm MacLeod** contributes another frontispiece. He has threatened to dynamite the TEN office if we fail again to give him credit for his work. Well, let it be known to the world that Malcolm also photographed the fine November and December frontispieces as well as the illustrations for several of the TEN articles.

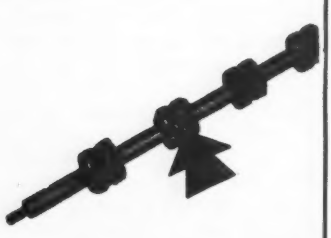
D.E.



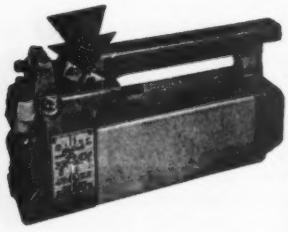
Replacing a rivet

. . . a hinge pin

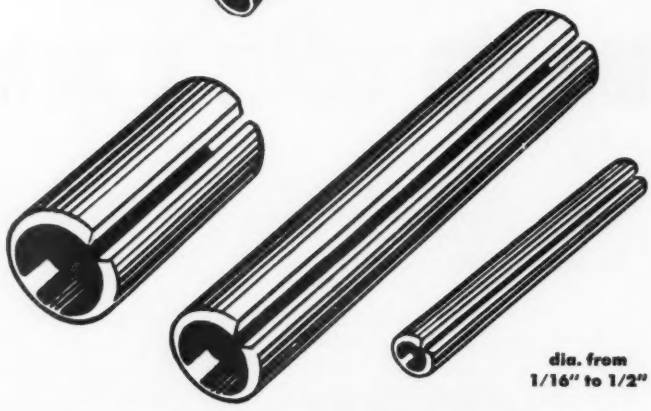
. . . a stop pin



. . . a set screw



. . . a bolt and nut



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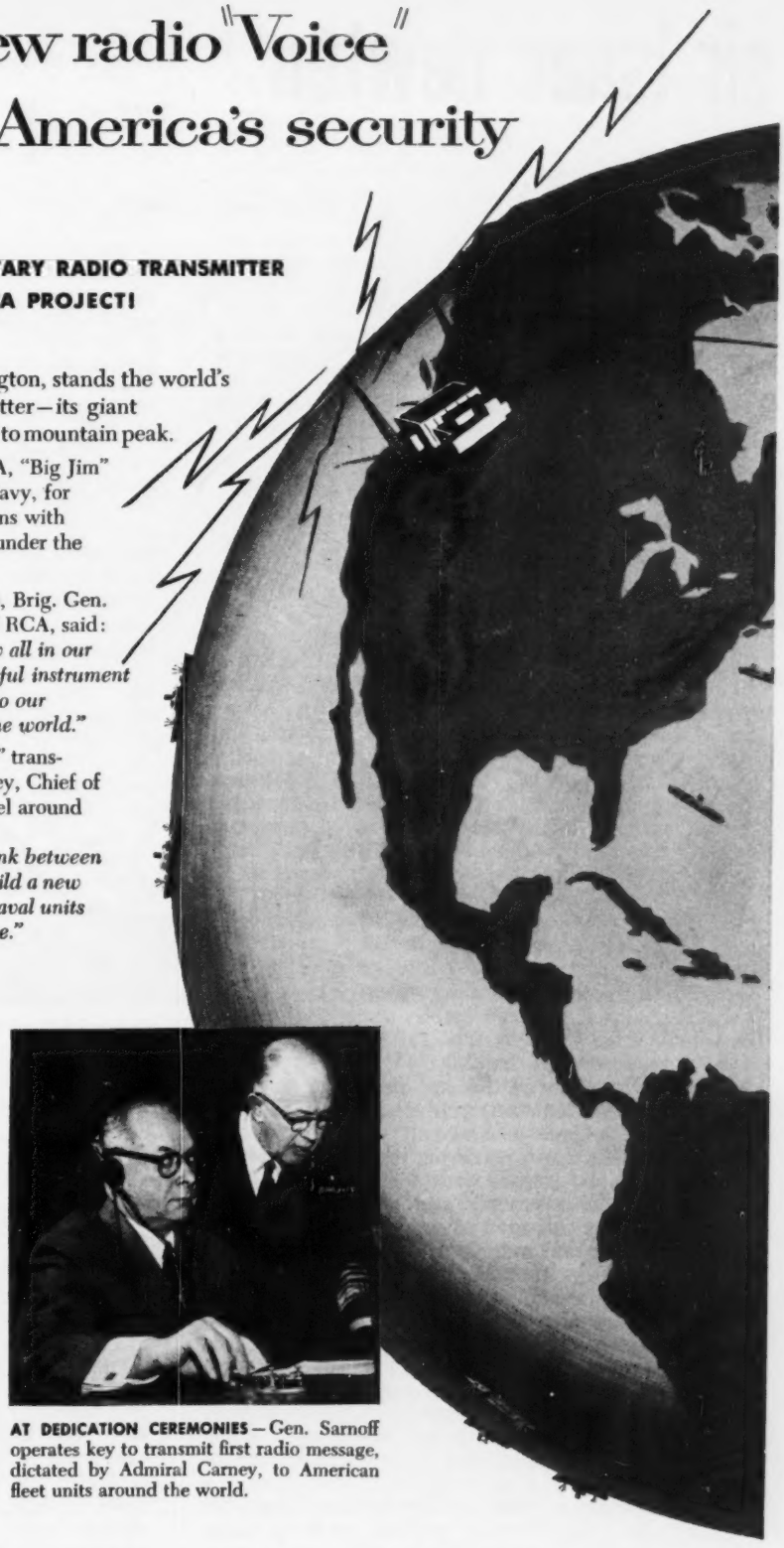

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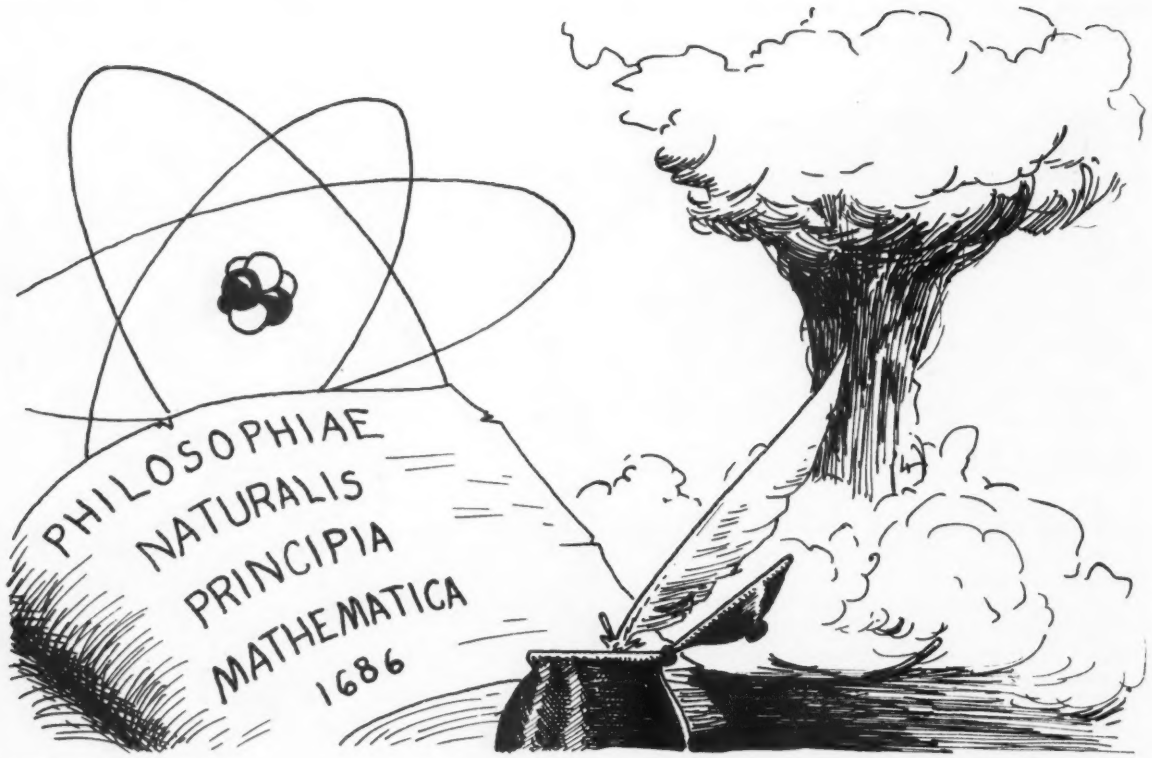
By Richard J. Hayes, '54



INTRODUCTION

It is the intention of this article to describe the life of Sir Isaac Newton, giving special emphasis to his contributions to humanity in the field of mechanics. This synopsis of his life is in the form of a biographical sketch with various outlines of his scientific achievements and comments on his personal history included to more fully illuminate the life of this great man.

Newton's works are amply evaluated in many of the textbooks used in colleges today and it is felt that there is no necessity to reproduce these analyses in this paper. However, by gaining an insight into the personal characteristics and environment of this man, supplemented by an enumeration of his scientific accomplishments, we will be better able to fulfill our objective and understand both the man and the effect of his work in the scientific world.

The eighty-four years of Newton's life can be divided into three distinct periods, and for purposes of clarity and continuity, this article will describe these stages separately and in chronological order.

Since any brief account of Newton's work must inevitably create an inadequate impression of his contributions to science, it should again be pointed out that the object of this article is merely to illustrate and comment upon the many achievements of Newton and by no means attempt to fully evaluate them.

Period I {1642 - 1669}

BACKGROUND AND EDUCATION

This twenty-six year period began with Newton's premature birth on Christmas Day in 1642, the year in which his able predecessor in the field of science, Galileo, died. Friends and relatives exclaimed that at birth Newton was tiny enough to fit in a quart mug. His physical characteristics as a young child resembled those of his father, who was frail and weak throughout his thirty-seven years, which ended shortly before the birth of his son and namesake, Isaac. These characteristics were in sharp contrast to the robust nature of his mother who remarried when Isaac was three and had two more children, neither of whom rose to a prominent position. Catherine, one of his four nieces, became Newton's favorite and lived in his house until his death. She became the object of many scandalous remarks by his enemies, but was

rewarded for her companionship by inheriting all of Newton's personal property when he died in March, 1727.

At public grammar school in Grantham, near Lincolnshire, England, young Isaac distinguished himself in mechanics and carpentering. His marks were not exceptional and he was classified by his teachers to be only an average student. His work in carpentering and mechanics grew out of a hobby that he enjoyed. He developed many ingenious devices including a waterclock, a sundial, and a model windmill. His method in making these devices was devoid of any analytical calculations and merely serves to illustrate his natural ability and creative genius within the realm of experimentation.

While attending school, Isaac experienced his initial and lasting infatuation for a member of the opposite sex, a young lady by the name of Story. He lived in her father's home as a boarder during the school year and became formally engaged to her when he was nineteen. Unforeseen financial difficulties developed which prevented their immediate marriage and separated them temporarily. By the time Isaac had established himself, after four years of concentrated study and absorption in his work, he learned that Miss Story had married. He never married, but remained her friend and benefactor for life. He claimed the reason for his bachelorhood was not due to a broken heart, but merely that he never became interested in any other girl. He was described by his colleagues as a very contended man who enjoyed his work and the companionship of his niece, Catherine, and her husband who lived with Newton until his death. In 1668, Halley, the famous astronomer, and Dr. Vincent (the husband, it is supposed, of Miss Story) were responsible for the presentation of the manuscript of Newton's *PRINCIPIA* to the Royal Society. Halley is now commonly referred to as the "guardian angel" of Newton's works since he paid for the printing and publishing of the manuscripts.

Newton's education at Grantham terminated at the age of fourteen when he had to return to the farm after his stepfather died. His formal education resumed at the insistence of his maternal uncle who caught him reading a technical book under a bush near his home when he was supposed to be helping a farmhand. There was nothing outstanding about his college years, beginning in 1660 when he entered Cambridge University.

Again, Newton established himself as a normal student by engaging in extra-curricular activities while obtaining satisfactory grades. His college diary records many instances of drinking bouts at the local tavern and describes a few gambling enterprises in which he participated. By being able to have many diversified associations and still maintain a good record, Isaac Newton was admired by both his teachers and his colleagues. He was described as being a "well rounded individual who should be a success in any field he chooses" by one of his admirers when he received his A.B. degree in 1664. This initial period of his life came to a climax when, after receiving his M.A. degree, he was appointed Professor of Mathematics at Cambridge University.

Period II {1669 - 1695}

ANNOUNCEMENT OF DISCOVERIES

The Bubonic Plague which forced Newton to interrupt his college education in 1664 has been appraised as being very influential in the life of this great man. After his hasty departure from the University, Newton returned to his home at Woolstorpe and occupied his spare time by meditating about his purpose in life and the position of the earth in the universe. In the three years during which he spent a great amount of time in the solitude of his garden, Newton achieved an understanding of the basic fundamentals of the discoveries which he later refined before their announcement. During this three year interval, he:

a) Invented the method of fluxions, now commonly called the calculus.
b) Discovered the concept of universal gravitation.
c) Observed the motion of the planets through a home-made telescope.
d) Proved the refrangebility of light which led to his corpuscular theory of light.

After the Plague had left its effect on the University's surroundings, Newton returned to receive his M.A. degree and then began teaching mathematics at the age of twenty-seven.

Before the work of this great man can be justly appraised, it is essential for one to understand his peculiar personality traits. Although he endeavored to be recognized as an average individual throughout his educational career, Newton never overcame the psychological effect of being ridiculed for his dimunitive body during childhood. He rebelled at being reprimanded and became very publicity shy during this period of his life. He developed a very modest opinion of himself and was never anxious to have himself considered a genius. When asked to comment on his own ability Newton once replied, "If I have seen a little farther than others, it is because I have stood on the shoulders of the giants."

There is little doubt that he had benefited from the experience of his predecessors—among them Descartes, who worked on analytical geometry, Kepler, who contributed three laws of planetary motion; and Galileo, who formulated two laws governing the motion of bodies. However, as E. T. Bell pointed out, "Bricks do not make a building; Newton was the architect of dynamics and celestial mechanics."

The effect of Newton's attitude upon his work cannot be fully understood until a more critical analysis of his accomplishments is made. Newton did not work in any one specialized branch of science for a considerable amount of time, but gave consideration to all the ideas and concepts without following any definite order or pattern. For purposes of clarity, his major contributions to science will be discussed in separate sections of this article.

1. OPTICS

While experimenting with various beams of light, Newton discovered that light was refrangible, or was capable of being refracted. He observed that a series of colors, or spectrum, re-

sulted when a beam of white light was directed at a prism. His experiments consisted mainly of observing the action of various filters on the rays of the sun. He also developed a reflecting telescope to observe the motion of celestial bodies. As a result of his work in optics, Newton developed a corpuscular theory to explain the various phenomena that he observed. His theory, however, was in sharp contrast to the wave theory of his contemporaries, Hooke and Huygens.

In 1672, when elected to the Royal Society, he anounced his work on optics, and a committee of three, including Hooke, was appointed by the Society to report on Newton's work. The Royal Society accepted all of Newton's theories after much deliberation during which he had to reply to the criticism and objections of foreign philosophers and Hooke. This was the first public instance when he showed his particular personality trait of being extremely adverse to opposition. On this subject he said, "I intend to be no further solicitious about matters of philosophy. I was so persecuted with discussion from my theory of light, that I blamed my own imprudence for parting with so substantial a blessing as my quiet to run after a shadow."

Consequently, Newton became so irked that he would not publish his books *Optiks* until after Hooke died in 1704.

Critics of Newton point out that he was responsible for retarding progress in telescope manfacture for twenty-five years when he announced that, as a result of his experiments, dispersion was always proportional to refracting power. The conclusion was immediately drawn that no combination of lenses could eliminate chromatic aberration. The main fault of some of his contemporaries was that they considered his word infallible. The above conclusion was the result of a few hasty experiments and was not intended by Newton to be accepted as a law of nature but more to serve as an incentive for more detailed research. Dolland fulfilled this objective in 1757, after Newton's death, when he found that a combination of crown and flint glasses would correct the phenomenon known as chromatic aberration.

2. FLUXIONS

The great controversy over the origin of the present day calculus results from Newton's reluctance to publish his work and the contributions of one of his contemporaries—Liebniz. Newton is given credit for first originating the calculus notation, but it was Leibniz who developed the system that is commonly used today. Leibniz worked independently of Newton and published his results first.

The basic concept which spurred both of these men was the idea of rate of change. In developing his system, Newton used the present day terminology of variables, functions, and limits. The basis for his work in this field was a "re-discovery" of the binominal theorem. However, when he was convinced of the validity of his system, he put the work away and concentrated on other fields. Leibniz used the $\frac{dy}{dx}$ symbol where Newton employed the $\dot{y}$ notation. Leibniz actually had all the symbols and terminology of both integral and differential calculus in use before Newton published his work. Followers of both sides claimed plagiarism and the great dispute followed. Leibniz was backed by the Bernoullis and he and Newton became bitter enemies.

It should be realized that Newton carried on developments from his laws sufficiently to make only rough estimates of the motion of bodies in the solar system. His method of proofs, generally supposed to be rigorous, was always geometrical. If he had used his new method of fluxions, it would have been necessary for his contemporaries to master the new method before they could understand its application. Whether it was from a desire to avoid controversy or to have immediate acceptance of his work, Newton cast all of his proofs in geometrical form.

3. GRAVITATION

Since Newton derived his theory of gravitation using Kepler's laws as a foundation, these three laws are reproduced here:

a) The planets move about the sun in ellipses, in one focus of which the sun is situated.

b) The radius vector joining each planet with the sun describes equal areas in equal times.

c) The cubes of the mean distances of the planets from the sun are proportional to the squares of their times of revolution.

Newton's law of gravitation is commonly stated as,

> "Every particle of matter in the universe attracts every other particle with a force inversly proportional to the square of the distance between the two particles."

In 1665, Newton began wondering whether this law was the same as the one that affected the flight of a stone around the earth. The popular notion that has been passed down through the ages is that while he was meditating in his garden, he observed the fall of an apple. However, all his calculations involve the earth and moon rather than apples.

He waited twenty years to announce the gravitational concept in his PRINCIPIA which was published in 1686. In the book, he introduced a theorem relating the proportionality of the quantity of matter, or mass, of the two bodies in question. Newton considered the action of gravitation as a force acting on each of the two bodies, and his law is expressed in the new familiar form:

$$F = \gamma \frac{Mm}{R^2}$$

γ is the proportionality constant that was measured experimently by Cavendish in 1798. By waiting twenty years, Newton's original calculations, involving the earth and the moon, were modified and the final results were substantiated by using the data of his contemporaries who were working in the same field. Although the reason for the twenty year delay is not evident from history books, it is probably safe to attribute a major portion of it to Newton's particular personality traits that were described previously.

4. LAWS OF MOTION

In his PRINCIPIA, Newton expressed his three laws of motion, or axioms, in the following manner:

Law I.

"Every body continues in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed on it."

Law II.

"The change of motion is proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed."

Law III.

"To every action there is always opposed an equal reaction: or, the mutual actions of two bodies upon each other are always equal, and directed to contrary parts."

Newton set up the parallelogram of forces concept as a corollary of his laws of motion but it is difficult to fathom why he considered the two concepts related. Nevertheless, the idea of the parallelogram of forces was stated as:

COROLLARY I

"A body, acted on by two forces simultaneously, will describe the diagnosis of a parallelogram in the same time as it would describe the sides by those forces separately."

His experimental genius was illustrated when he performed his pendulum experiments to find the relation between the material used for the bob and the period of oscillation. Carefully safeguarding against the resistance of air by removing the interior of the spherical bobs to make them equal size and weight, he concluded that the period of oscillation was independent of the material used for the pendulum and that W equalled MG in all cases.

A controversy which has been prevalent since the publication of Newton's works originates from his use of the force concept.

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Critics point out that there are only three fundamental units—mass, length, and time. They claim that the use of the term "force" is unnecessary. However, Newton used this term as a convenient basis for his explanation of mechanics and his work, using the force concept, has well withstood the test of time. Critics also point out the ambiguity arising over his definition of mass, or quantity of matter, which is:

> "The quantity of matter is the measure of the same, arising from its density and bulk conjointly."

On this subject Mach said, "As regards the concept of mass, we remark first that Newton's formulation which defines mass as the quantity of matter of a body, determined by the product of volume and density, is unfortunate. Since we can define density only as the mass of unit volume, the circle is obvious."

However, Crew pointed out, "In the time of Newton, density and specific gravity were employed as synonymous, and the density of water was taken arbitrarily to be unity. The three fundamental units employed . . . were therefore density, length, and time. On such a system, it is both natural and logically permissible to define mass in terms of density."

There are many other interesting controversies which have arisen over the publication of Newton's work, and series of textbooks have been written offering various opinions on the subject matter. As a concluding section in the description of the second phase of Newton's life, it is interesting to note a remark by Florian Cajori which appears in the appendix of his translation of the PRINCIPIA. Although the comment appears with reference to Newton's remarks on rectilinear motion and absolute time, its content would be applicable to many other examples. Cajori said, "It would seem to follow, therefore, that the existence of absolute rectilinear motion and of absolute time are postulates made in Newtonian mechanics; they are not based on experimental evidence and may therefore be said to be metaphysical. There appears to be no 'a priori' argument against acceptance as a foundation in mechanics of concepts, some of which are observable and others unobservable or metaphysical. The two types of concepts might form a perfectly solid and coherent structure which yields results in accord with observational data, to a degree of accuracy lying within the probability of experimental error. Indeed, Newton's assumptions satisfied this test in the scientific developments extending over a period of two hundred years. During that time, astronomy and physics made tremendous strides forward. Celestial mechanics flourished; so did engineering and physical science."

Period III {1695 - 1727}

FAME AND POWER IN LONDON

The third stage in Newton's life is in sharp contrast to the others. This thirty two year period began after a long illness which nearly resulted in his complete mental collapse. The cause of Newton's severe illness is hard to determine, but it is presumed that the long, hard work which he put into the writing of his famous PRINCIPIA imposed a great strain on his physical and mental endurance.

An unfounded story has been passed down by historians that a light burning in his home while he attended chapel services resulted in the destruction of his study room. The story continues by saying that Newton suffered a mental collapse when he discovered that the fire destroyed twenty years' work on optics which he had hidden in his desk. This story was not substantiated, however.

Letters written during his two year illness prove that he did not lose his sanity and that he had completely recovered from the relapse in 1695. He then gained a great many friends at the University by leading a group of Professors in a court case in London, but this taste of city life proved to be his scientific undoing. He secured an appointment as warden of the mint and worked hard at his new task. He was rewarded by becoming Master of the Mint which is similar to the Collector of Internal Revenue in this country. Newton became a very rich, influential man and enjoyed life while in politics.

In 1712, he and his followers created the controversy over the origin of calculus. During this period, Newton's mind remained very keen as he rapidly solved problems that were sent to him by his enemy, Leibniz, as major tests of his ability. Newton bequeathed the major portion of his personal property to his niece, Catherine, upon his death in March, 1727.

SUMMATION

It has been pointed out that aside from being a great scientist, Isaac Newton was a well rounded man who enjoyed a full life. His purpose in science was to try to determine nature. His major achievements in the field of mechanics are summarized by educators as follows:

1. Introduction of the law of universal gravitation.
2. Generalization of the term "force".
3. Introduction of the concept of mass.
4. Complete formal enumeration of mechanical principles which are now generally accepted.
5. Introduction of the statement of action and reaction.
6. Distinct formulation of the concept of the parallelogram of forces.

There are many monuments in science today which serve as a tribute to the work of this great man. One of his greatest attributes, which is not evident from many textbooks, was a sense of modesty which is reflected in the following self-quotation which he made near the end of his life and which ably concludes this bibliographical survey:

> "I do not know what I may appear to the world; but to myself I seem to have been only a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.

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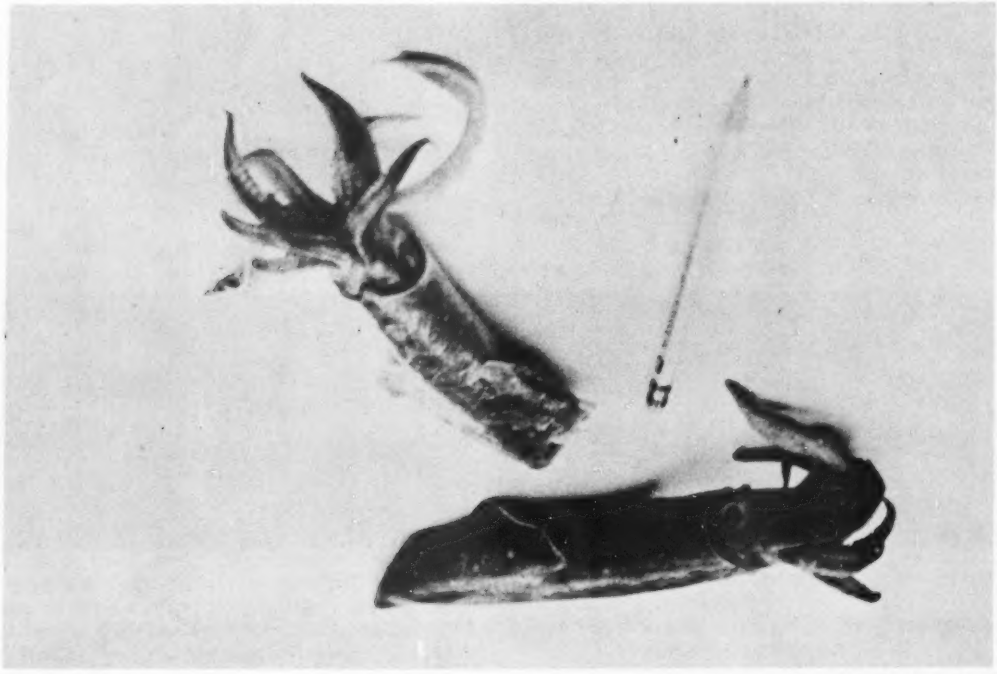
loligo

A Boon to Nerve Research

By Thayer C. French, '57



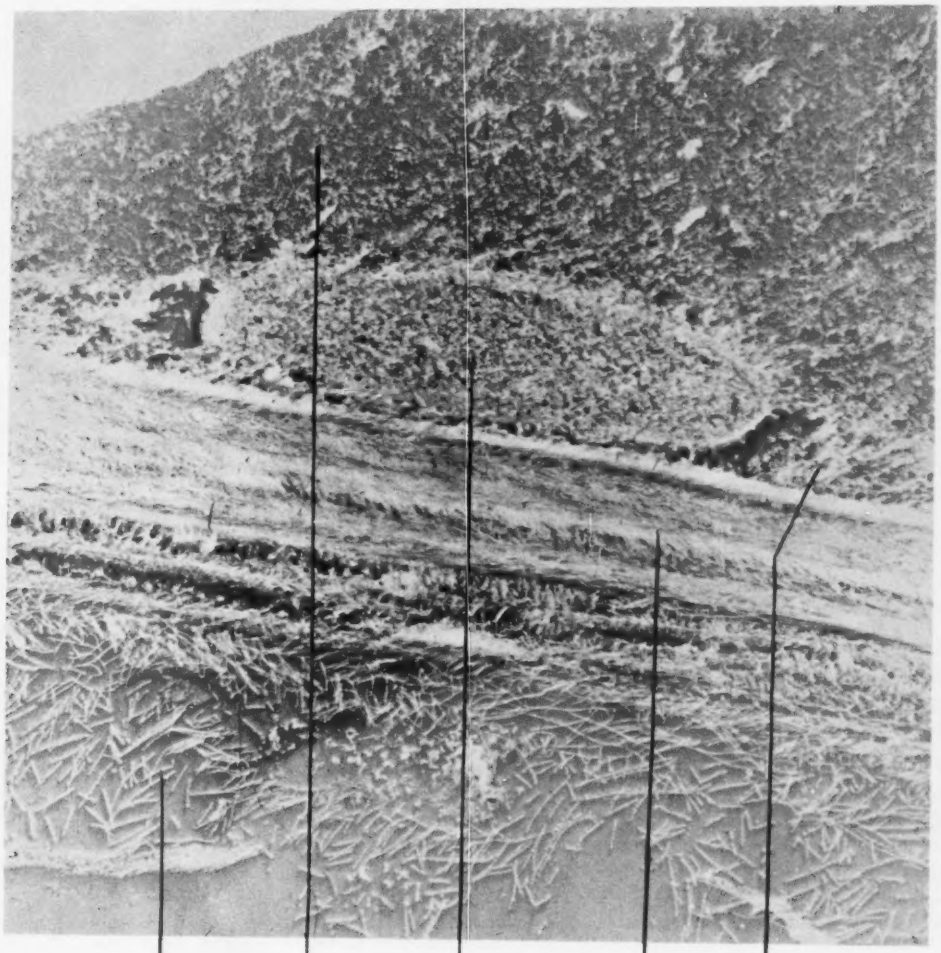
The ultra-structure of the nerve axon has been a controversial matter for many years. With the improvement of histological techniques and more extensive and efficient use of the electron microscope, the ultracentrifuge, electrophoretic and chromatographic apparatus, and polarization equipment, have come some recent advances in nerve physiology. In particular, a team of biologists and chemists under Dr. Francis O. Schmitt, Head of the Institute's Department of Biology, have partially succeeded in characterizing the fibrous structure of axoplasm, the gelatinous filling of axons.

It is well-known that the velocity of a nerve impulse increases with the diameter of the nerve. It is, therefore, logical that an animal possessing nerves specialized for a speedy reflex action will have giant nerve fibers suitable for extrusion of relatively large quantities of axoplasm. In addition, the ideal animal must be rather abundant, readily obtainable, and conveniently large; it must be kept alive until the nerves are to be dissected. For this particular locality the Institute researchers have chosen the common squid, *Loligo pealii*, as most closely approaching the ideal.

The two dorsal giant nerve fibers radiating from the squid stellate ganglia are involved in a startle reaction—the expulsion of ink for which the squid is infamous—and are about 0.5 mm. in diameter and 5 cm. long when cleaned of all connective tissue and associated fibers. A single dorsal giant fiber yields about 5 mg. of axoplasm, equivalent to 0.6 mg. of axoplasmic solid. Because some 30 mg. of this solid are required for most experiments, fifty squid must be dissected for an average single experiment. The staff decided that it would be more economical to devise methods for collecting and transporting the squid to Cambridge than to move its equipment to the Marine Biological Laboratory at Woods Hole, Massachusetts—hence the Squid Truck, a box-like affair which graces the East Campus parking lot.

During the summer, squid freshly caught in the commercial fish traps near Sakonnett, Rhode Island are transferred from the nets to a barrel of circulating sea water. At the dock the squid are gently agitated, encouraged to eject their ink, and then transferred to fresh sea water in the conical squid tank aboard the squid truck. The squid tank is flushed to remove any remaining ink, the storage tank valve is opened, and the squid are supplied continuously with recirculated, aerated, refrigerated sea water maintained at a temperature below 22°C., preferably between 15°C. and 19°C. After an eighty-five mile trip by squid truck, and approximately four hours after the catch, the dis-

ELECTRONMICROGRAPH OF CROSS SECTION OF SQUID GIANT FIBER (TAKEN BY DR. B. B. GEREN)



(MAGNIFICATION = 14,800)

section begins at the Institute. Sea water piped from the storage tank on the truck flows over the squid dissecting boards; the nerve bundles are dissected from the squid mantles in this medium under a dissecting microscope. A glass rod, rolled over the cleansed and rinsed fiber which is placed on a parafilm-covered microscope slide, extrudes the axoplasm in much the same fashion as a cultured American squeezes toothpaste out of a tube. The viscous extruded axoplasm is easily rounded into a spherical drop and transferred with forceps into the proper solvent.

There has been much discussion about two fibrous structures present in axoplasm: the so-called neurotubules, long, dense-edged bodies about 500 A. in diameter, which appear to be hollow tubes; and *neurofibrils*, longitudinally oriented filaments 100 to 150 A. in diameter, and indefinitely long. In electron microscopical studies Fernandez-Moran (1950) and Drs. Francis O. Schmitt and Betty Ben Geren here at the Institute (1950) have identified neurotubules as definitely non-axonic constituents of nerve tissue, and most probably collagen fibrils belonging to the external sheath layer. Supporting this statement is the fact that dense-edged fibrils were not observed in

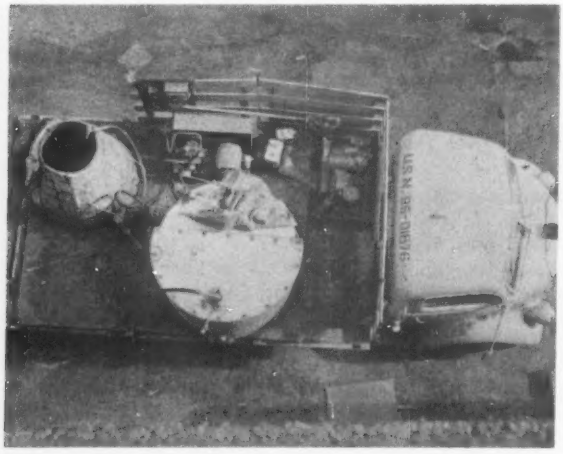
unfixed, extruded axoplasm of squid giant fibers. The axoplasm from nerve tissue infected with poliomyelitis virus and virus B was then examined for neurotubules; any increase in the number of these bodies would seem to indicate one of the specific actions and symptoms of these diseases. No neurotubules were observed, however, except possibly as contaminants of isolated axon preparation, and therefore it is clear that neurotubules are not structural entities of normal intact axoplasm, and are not involved in axoplasmic degeneration from polio or virus B.

Institute biologists dissect fresh squid.

Research efforts were concentrated upon the more interesting neurofibrils. The optical polarization studies of Dr. F. O. Schmitt established a weak value for positive birefringence in the axial direction of the axon, indicating the presence of a longitudinally oriented submicroscopic component with internal structural regularity, and constituting a small volume of the axoplasm. Soon after the polarization optical studies, electron micrographs of chemically "fixed" and unfixed samples of squid axoplasm verified the previous results. In fixed preparations the axon filaments have nodular enlargements along their length but no regular period is present. They appear smoother when fresh axoplasm is dispersed in distilled water. These filaments may be broken up into shorter ones *in vivo*. In any case they are considered to be part of a protein complex, "neuronin," which is generally characteristic of nerves. Using ultracentrifuge and electrophoretic techniques in one of the more recent nerve studies, Dr. Myles Maxfield of M.I.T. has succeeded in isolating and characterizing a fibrous protein, which is considered to represent the chief component of neurofibrils. He has demonstrated a "reversible globule-fiber transformation," that is, a reversible depolymerization, of this protein. Exactly how this globule-fiber protein is related to nerve impulses is a moot question.

Electron microscope magnifies squid axon filaments 25,500 times.

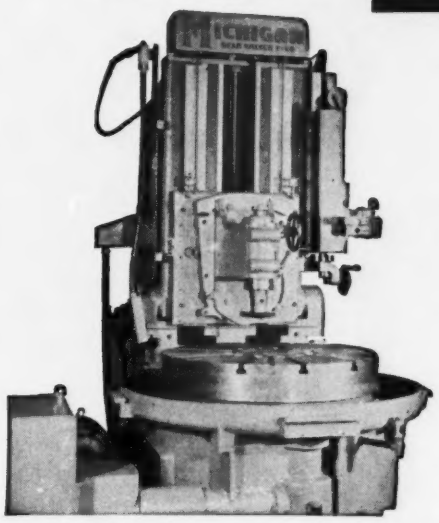
Perhaps of more interest and impact than any single discovery in the morphology of axoplasm is a recent advance in nerve chemistry. Dr. Bernard Koechlin of M.I.T. has isolated, identified, crystallized, and purified a substance responsible for approximately one half of the anions in the squid nerve. The high concentration of K^+ cations and of Na^+ cations outside of the plasma membrane suggested the presence of anions other than those already identified, and specific for Na^+. The compound extracted by Dr. Koechlin is chemically similar to taurine, a sulfur-bearing amino acid. This discovery may throw some light upon the mode of transmission of nerve impulses and, along with tracer studies which will begin next summer, should give important clues to nerve metabolic processes.



The M. I. T. squid truck is prepared for another catch.

The nerve studies at the Institute have extensive possibilities. A more thorough understanding of nerve phenomena, say to the extent of our present knowledge of muscle physiology, would be first of tremendous import to the medical and psychological professions, and so eventually to the layman. Judging from past discoveries and technical advances there is good reason to be optimistic about future success in the "Squid Program," and nerve studies in general, at M.I.T.

Another page for **YOUR BEARING NOTEBOOK**



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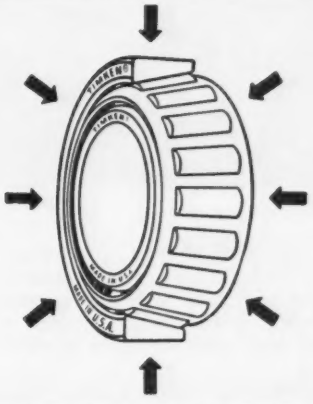
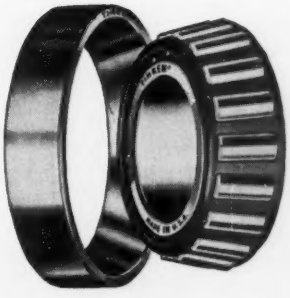
Deflection is minimized, end-play and chatter eliminated because the tapered construction of Timken bearings enables them to take *any* combination of radial and thrust loads. Line contact between rollers and races gives spindles wide support for extra rigidity.





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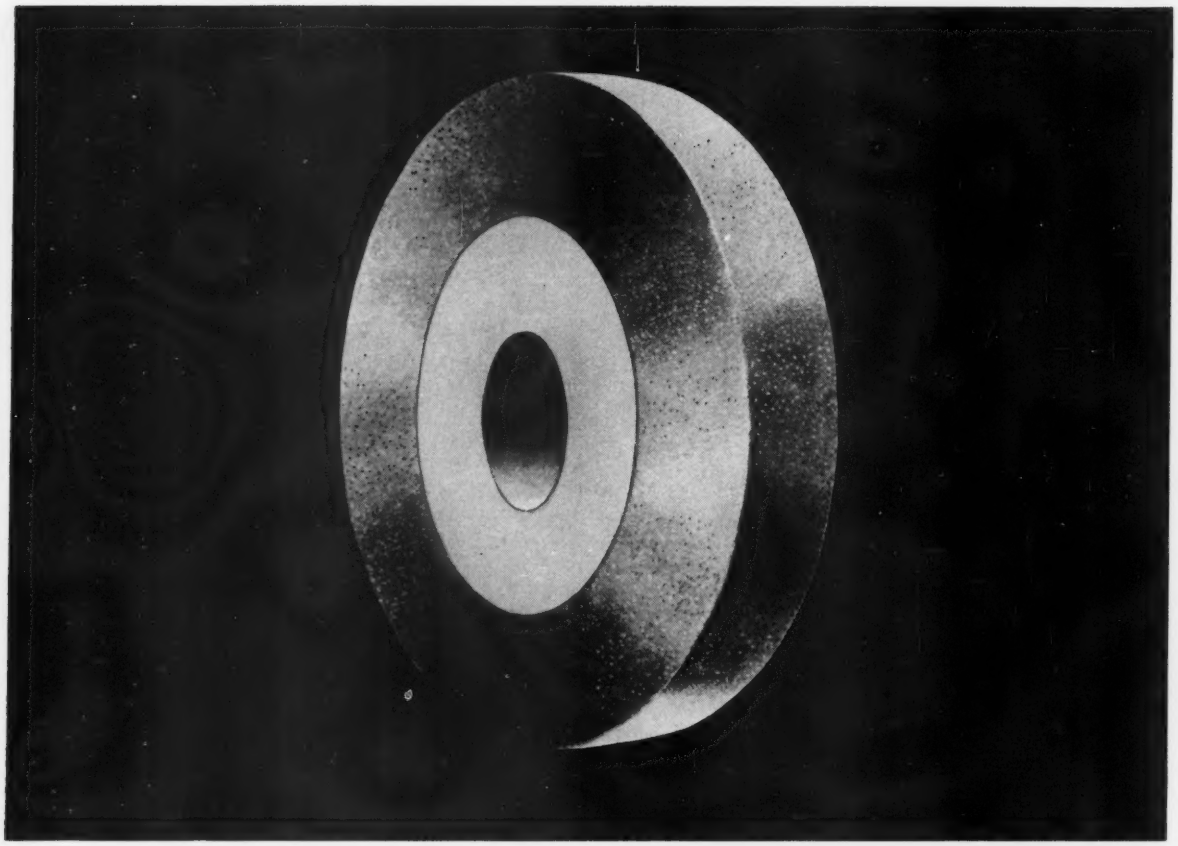

HIDDEN HENCHMAN . . .

Early man used Nature's rocks and stones to shape and sharpen his crude tools and weapons. Today, industry has at its command abrasives that will do in seconds jobs that formerly required days of tedious toil.

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But it was by the discovery of silicon carbide and crystalline fused alumina—man-made minerals from the electric furnace—that the grinding wheel became a high speed, precision production tool.

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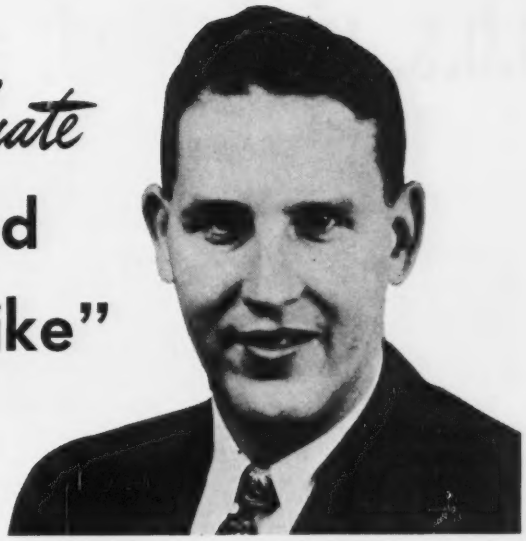
"Allis-Chalmers Graduate Training Course Helped Me Find the Work I Like"



says HUGH C. SELLS,
Syracuse University, BS—1942
and now Manager, Knoxville District Office

"I guess I was like many graduating engineers. I didn't really know what I wanted to do. When the Allis-Chalmers representative visited the campus, and described their Graduate Training Course, it sounded like the type of postgraduate training I really needed.

"What appealed to me then—and still does—is the broadness of the program. Here is a company filling a unique spot in industry. It makes important, specialized equipment for almost any industry you can name."

Wide Choice of Activity

"It's like a big department store for industry. But that isn't all! In addition, it offers a wide choice of activity within each of these many product groups . . . whether it be sales, design, research or production.

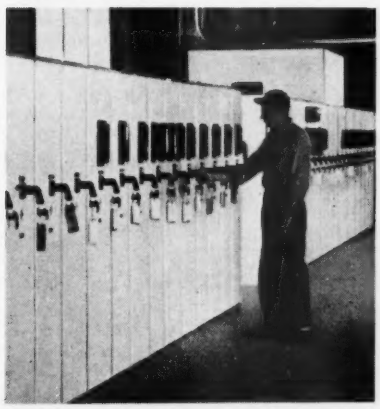
"After getting the broad look at industry the program offers, my interest began centering on Service and Erection of large equipment. This led me into many departments of the company, and I learned about everything from steam turbines to sifters for flour mills."

Valuable Background

"The transition from service to sales was natural. The background of service and erection work proved very valuable.

"So you see, whether you think you know what you want to do or not, the Allis-Chalmers Graduate Training Course is so flexible, so broad in its scope, you have a real chance to find yourself. Best of all, you don't have to waste time doing it."

ELECTRONICS—Modern way to dry sand cores is with Allis-Chalmers *Foundromatic* Sand Core dryer. Revolutionary new process dries cores in minutes instead of hours.



POWER—Neat, compact and safe switchgear installation is big improvement over open framework and knife switches in older installations.

Facts You Should Know About the Allis-Chalmers Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

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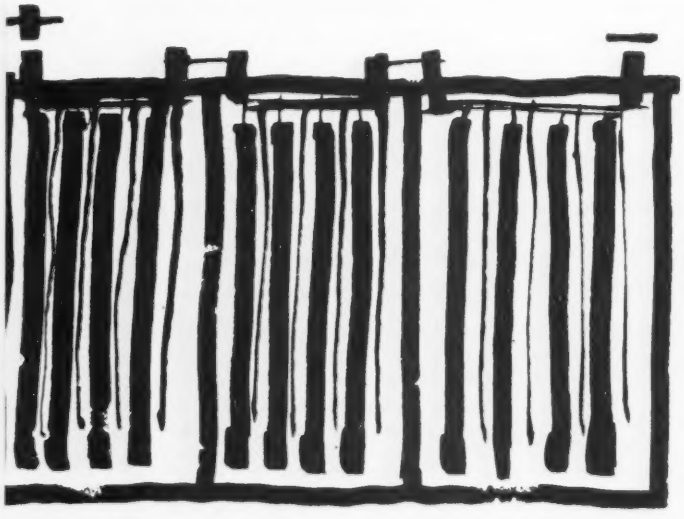
n.b.s. vindicated: ad-x2 "without merit"

By John F. Wells '54

The Jeffries Committee, named by Secretary of Commerce Weeks to investigate all claims on the value of the controversial battery additive AD-X2, finally upheld the work of the National Bureau of Standards while rejecting the M.I.T. tests for lack of control.

In the March issue of the Tech Engineering News, this author presented what he considered a very interesting, if not amusing, incident in the annals of scientific investigation: an apparent controversy between two of the foremost scientific institutions in the world, the National Bureau of Standards and M.I.T., over a battery additive, called by its manufacturer AD-X2. The N.B.S. had claimed the additive worthless, while M.I.T. tests showed otherwise. The conclusion of that article reads as follows:

"It is interesting to note that the M.I.T. results were submitted without interpretation, and the men involved in the tests offered no further comment on the report to this author when interviewed, thus leaving the interpretation of the



carefully compiled data to others and thereby avoiding any possibility of embarrassment.

"The primary interest of this situation to us may not lie in whether this battery additive is effective or not, although this may be of great importance, nor in the fact that a routine test led to a four year battle, but in the peculiar circumstances by which it arose. It emphasizes, again, that the human element is a very difficult thing to eliminate in science as in anything else, not only when the time finally comes to interpret the mass of accumulated data but also in the means and methods by which those data resulted."

It was no small surprise to many when this affair blew up into a political feud resulting in the forced resignation of Allen V. Astin, Director of the N.B.S., by Secretary of Commerce Sinclair Weeks, on the basis that Astin and the N.B.S. were not objective in their tests and had not taken into consideration the "play of the market place". The dismissal caused a storm of protest in scientific circles. Weeks later reinstated Astin on a temporary basis and finally on a permanent basis after the report issued by the Kelly Committee (a separate nine man committee appointed to evaluate the N.B.S. as a whole. Its finding: "a splendid record").

A prior agreement was made by all interested parties including Astin and Jess M. Ritchie, president of Pioneers, Inc., makers of AD-X2, that the findings of a ten-man committee, appointed by the National Academy of Sciences, to resolve the additive dispute, would be final and definitive. Zay Jeffries of the G.E. Chemical Division was named chairman.

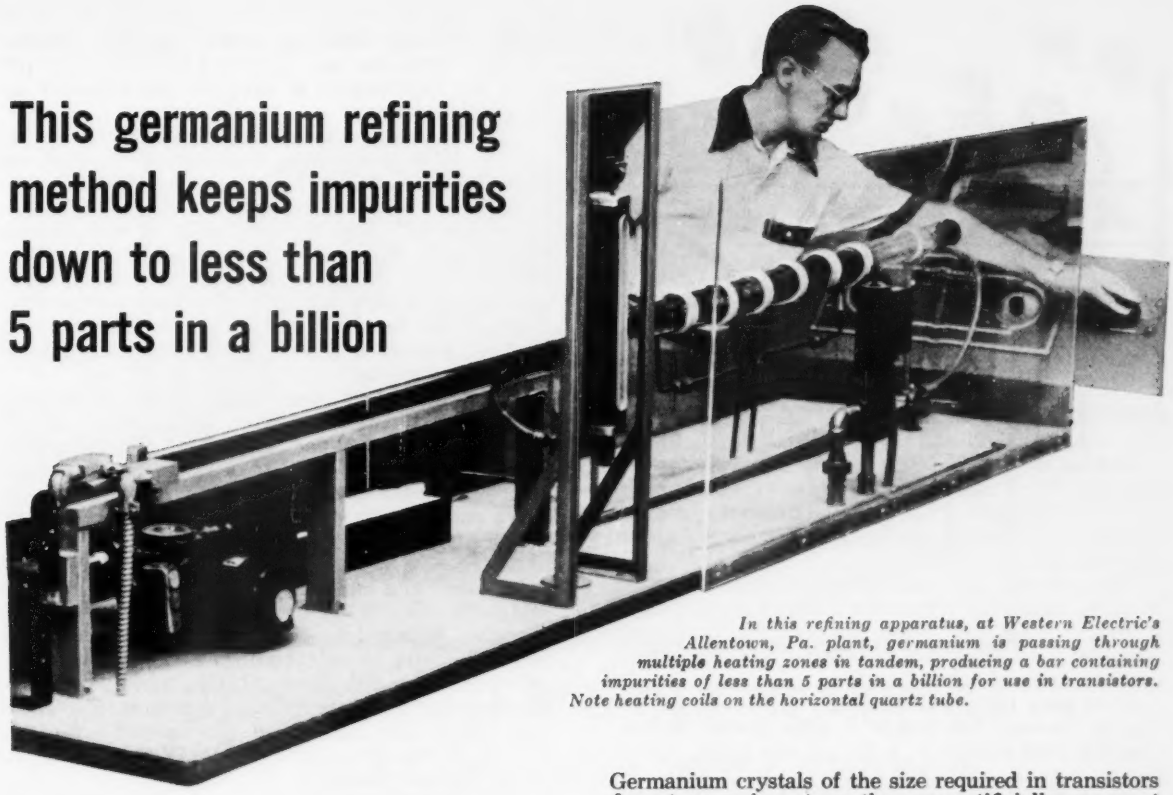
In a nine and one-sixteenth pound report, the Jeffries Committee concluded that "the quality of the work of the National Bureau of Standards in the field of lead acid storage battery testing is excellent . . . Our opinion is that the quality of the work of the Bureau in this field is better now than at any time in the past". The committee chose only four tests out of all submitted, rejecting the M.I.T. tests as not having enough batteries for control. The committee felt that the apparent controversy and differences of results between the M.I.T. report, claimed favorable to AD-X2, and the N.B.S. report, which was unfavorable, arose, not because of differences of any importance, but because of interpretation put on the M.I.T. report by a consultant of the Small Business Committee, Dr. Keith J. Laidler, and publicity relating to the interpretation. With regard to differences, the committee felt that if a more random statistical selection of cells to be treated had been made by M.I.T., results would have been the same as the N.B.S.

So ended the "battle of the batteries"!

But what about the doomed substance, AD-X2? Says manufacturer Ritchie, "Whitewash . . . I'll be whipped on this when they pat me on the face with a spade".

Well, a Cleveland industrialist, C. Greif Raible, has come up with an ultimate solution to the problem of cranky storage batteries, battery additive or no. It is a new, all weather hydraulic starting device called the "Hydrotor". It eliminates the use of storage batteries in starting engines!

This germanium refining method keeps impurities down to less than 5 parts in a billion



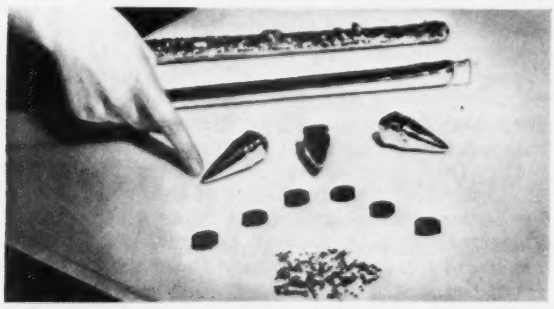
In this refining apparatus, at Western Electric's Allentown, Pa. plant, germanium is passing through multiple heating zones in tandem, producing a bar containing impurities of less than 5 parts in a billion for use in transistors. Note heating coils on the horizontal quartz tube.

A new method of metal refining, currently in use at the Western Electric plant at Allentown, results in the production of germanium that is better than 99.9999995% pure – the highest degree of purity ever attained in a manufactured product.

The need for germanium of such exceptional purity came about when research by Bell Telephone Laboratories in the field of semi-conductors led to the development of transistors, which are manufactured by Western Electric.

The transistor is a tiny crystal device which can amplify and oscillate. It reduces space requirements and power consumption to a minimum.

Various forms which germanium takes before being used in transistors are shown in this photo. Bar at top is an ingot of germanium after reduction from germanium dioxide. Next is shown the germanium ingot after the zone refining process used by Western Electric. Below the ingots are shown 3 germanium crystals grown by machine, 6 slices cut from these crystals, and several hundred germanium wafers ready for assembly into transistors.



Germanium crystals of the size required in transistors do not occur in nature; they are artificially grown at Western Electric. At this stage in transistor manufacture, other elements are introduced in microscopic quantities to aid in controlling the flow of electrons through the germanium. But before these elements can be introduced, it is necessary to start with germanium of exceptional purity, so that the impurities will not interfere with the elements that are deliberately added.

So Bell Telephone Laboratories devised an entirely new method of purification, known as zone refining, which was developed to a high-production stage by Western Electric engineers.

In zone refining a bar of germanium is passed through a heat zone so that a molten section traverses the length of the bar carrying the impurities with it and leaving behind a solidified section of higher purity. By the use of multiple heating zones in tandem, a number of molten sections traverse the bar. Each reduces the impurity content thus producing a bar which contains impurities in the amount of less than five parts per billion.

Because of the importance of the transistor in electronics, the zone refining process – like so many other Western Electric developments – has been made available to companies licensed by Western Electric to manufacture transistors.

This is one more example of creative engineering by Western Electric men. Engineers of all skills – mechanical, electrical, chemical, industrial, metallurgical, and civil – are needed to help us show the way in fundamental manufacturing techniques.

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Chorus and Orchestra of the New Orchestra Society, Paris René Leibowitz, cond.; R. Lewis, tenor; E. Semser, soprano; N. Tangeman, mezzo-soprano; F. Gruber, tenor; J. Riley, bass; aprox 119 min. NAB curve.

(This column may, or may not, become a regular feature, depending on reader reaction. In any case, if every magazine from Radio and Television News to the Ladies Home Journal has run record reviews, why shouldn't we?)

It's a long jump from Haydn to Schönberg, but Haydn Society has made it and landed safely. Owning this album is both an education and a treat.

First, the education. Those of you who have heard Schönberg's Pierrot Lunaire, Ode to Napoleon, or Survivor from Warsaw know of his Sprechgesang (speech-sing) and his twelve tone scale. You may have heard his Transfigured Night and know the resemblance this work bears to that of Mahler and Wagner. Hearing the Gurre-Lieder announced over the radio, without any preparation, one does not know whether he will hear modern dissonance or romantic melody. You'll hear mostly romanticism, with important signs of Schönberg's modernism.

An excellent and thorough booklet comes with the album; in it René Leibowitz describes this work as Schönberg's turning point, where he summed up all the ideas and ideals of 19th Century Romanticism, yet uses them to produce something new. He compares the Gurre-Lieder with the Ninth Symphony, Beethoven's turning point. Leaving aside any question of the relative greatness of the two composers, a question, possibly without meaning, the music lover of today or a century from now can only answer for himself, the point is valid. In the Ninth Symphony Beethoven used the elements of the classical symphony to produce something new. Compare, also, his post-Ninth piano sonatas and string quartets with those preceding the Opus 125 Symphony. And note the difficulty people even today have in learning to enjoy these works.

Because it sums up so completely Romanticism the music should be enjoyable to any lover of Berlioz, Wagner, or Mahler. Although not a fervent devotee of any of the above, I enjoyed the Gurre-Lieder upon first hearing, without the benefit of the words, translation, or the plot contained in the booklet. It held my interest as *music*, without theatrics, more than any serious Wagner opera can do. Repeated listenings do not bring me any weariness over certain passages as some Mahler does.

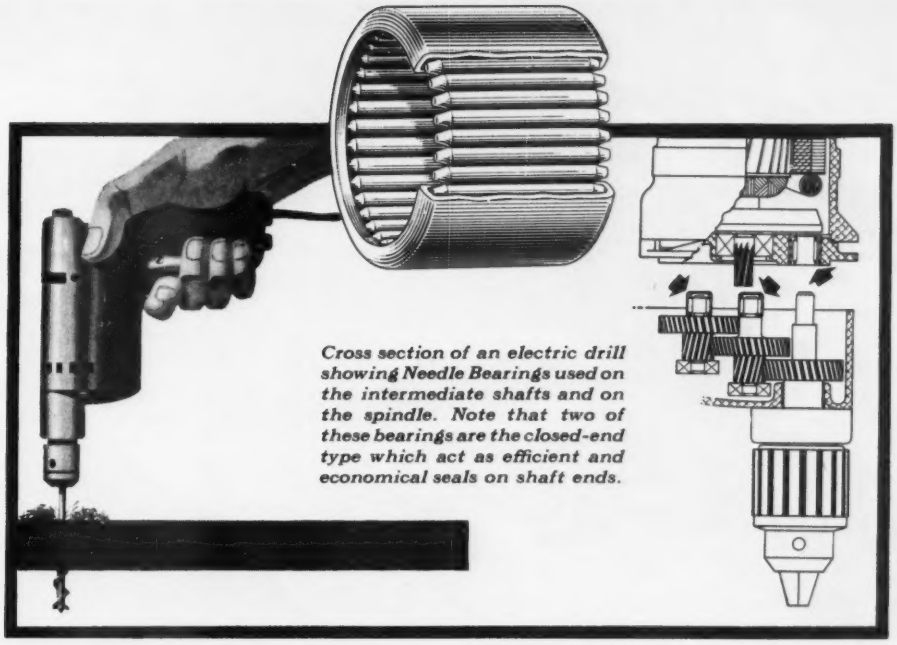
The plot is simple. The Danish poem Schönberg set to music in German translation, written by Jens Peter Jacobson, involves the Castle Gurre, built for the mistress Tove by the king, Waldemer, the death of Tove at the hand of the Queen, Helvig, and Waldemer's pursuit of and eventual reunion with Tove. Leibowitz terms the work a drama-symphony; it is somewhat comparable (though he does not make the comparison) to Berlioz' Romeo and Juliet as a combination of poetry and music.

René Leibowitz has made other Schönberg recordings, notably for Dial. As an active champion of Schönberg and a pupil of the composer, he can conduct the definitive performance if anyone can. The orchestra plays uniformly well, always suave, often gentle, sometimes forceful, but never rough. The soloists are very effective in a beautifully restrained way, again forceful when necessary. The enunciation of the German seems excellent—to this reviewer who cannot understand German. Richard Lewis, tenor, as Waldemer, the principal part, is outstanding. The chorus is very effective, but not clear at all, perhaps due to microphone blasting, in loud passages. For those interested, the large iron chains are heard on side 2, about the middle, before Waldemar's "Es ist Mitternachtszeit."

The advertisements for this album seem calculated to arouse the interest of high-fi fans. This interest is justifiable, but don't expect the miracle of the year in reproduction. As noted above there is some blasting of the microphone (Telefunken!) affecting occasionally both the chorus and soloists; but this is not an uncommon fault on many excellent recordings, and, when played on decent equipment, not serious here. If your stylus is worn, if your speaker system has resonances, or if your amplifier is incapable of putting out the dynamic range required, watch out, you'll hear it! The reproduction of the orchestra is really fine, with the unusual instruments (xylophone etc.) standing out sharp when necessary. On my equipment the recording sounds best when given slightly less treble cut than the NAB curve specifies.

Columbia pressed the records, and surfaces vary. I'd say they're poor, but then that would be true of 95% of all Columbia pressed recordings. There is absolutely no excuse for anything but absolutely silent recordings in this day of the microgroove. Having learned to hear the music through the "breakfast food" (snap, crackle, pop) on nearly every recent recording you'll agree that for a high fidelity recording of the highest musical interest this record will be hard to beat.

Oh! One more thing. RCA is rereleasing the 1932 Stokowski performance of this work. I have never heard it so should not make a comparison. However, it is said that Stokowski's direction never did please the composer, there are deviations from the text, and the recording was never considered excellent. Do make the comparison yourself, however, as I will; but I'll keep the Haydn Society's.



Cross section of an electric drill showing Needle Bearings used on the intermediate shafts and on the spindle. Note that two of these bearings are the closed-end type which act as efficient and economical seals on shaft ends.

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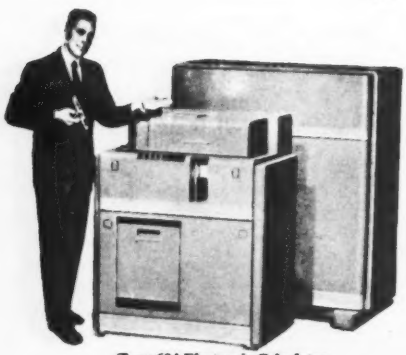

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engineering abroad

The Problems of Foreign-Trained Engineers Working in Countries Recently Being Industrialized

By R. P. Nanavati, G.

Indian engineers who have received their technical training in the United States, and who have subsequently gone home, fall mostly into one of two groups. The first is the happy group of very successful engineers; the second is the somewhat sad bunch of great failures. We might do well to examine some of the causes of the existence of the latter group.

The several stumbling blocks that the young foreign-trained engineer finds strewn in the most odd places are both technical and human in nature. Let us first examine the technical problems. As the American engineering colleges offer an excellent opportunity to specialize to a high degree in any given field, it is very difficult to resist the temptation of specializing too much. For instance, of what tremendous use would knowledge of special applications of transistors in computers be, if one does not in the first place know if one is going to find job opportunities in companies doing work in power or electronics? It is entirely possible that a man with such a specialized knowledge may find himself working on transformers!

Almost all the knowledge that this young engineer gets about practical problems and their solutions is based upon the environment in the U.S.A. But when he goes home he will find himself in an entirely new environment where neither the problems nor the available instruments bear any resemblances to the ones he had worked with in the U.S.A. The bubbling stream of newly acquired knowledge is bound to prompt the young engineer to suggest new methods of production or new ideas on solving problems. This enthusiasm is soon dampened by the cold reception that the new proposals get from the "old-timers." A general mistrust of modern methods, largely due to a lack of experience with them, is the chief cause of the cold reception given to new ideas.

As though these stumbling blocks were not enough, there are many human problems which confront the young engineer. Unfortunately in the past altogether too many engineers trained in the West went through so much Westernization that they seemed like strangers to their own people. A good many of these "strangers" also had been vehemently over-critical of conditions in the Indian factories without bothering to find out the causes of their existence. During the several years that they spent in the West learning engineering their values of things and ideas changed. When they came home, they still clung to this newly-acquired framework of reference, and judged all things according to it. They failed to see that what may be perfectly acceptable in the United States may be most objectionable in India, and vice versa. Consider, for example, the fact that because labor is difficult to find and costly to pay for, it pays the manufacturers in the United States to have the maximum number of automatically controlled processes even though these require a large initial outlay of capital. In India, however, where labor is relatively easy to find, but capital is not, it does not make sense to expect and advise that the industrial processes should be automatically controlled.

Many of these young engineers also, unfortunately, brought back barrels full of pride, and false sense of prestige. They felt that they had *the* knowledge; of course only they could say what was right and what was wrong! They laughed at the limited knowledge of people around them in the subjects of their specialization.

What kind of feeling could this kind of an attitude create in the minds of those around them other than resentment and prejudice? To top all this off there exists gross inequality in pay between the foreign-trained engineer and a graduate of an Indian university. So we see that these sad experiences with *some* formerly foreign-trained engineers could develop a most unhealthy antipathy towards *all* foreign-trained engineers.

What can an engineer trained in United States do about this state of affairs when he gets back to India? A great deal can be done if he has or develops the right kind of attitude. He should understand the background of whatever resentment that exists against Western-trained engineers. He should then proceed to fold his halo, clip his angelic wings, and climb down from the seventh heaven. If he shows a respect for the experience which his fellow worker has and which he himself grimly lacks, and if he at once accepts other Indian engineers as at least his equals, then he will have made a good start in diluting the prejudice of others against him.

If his new suggestions are turned down, he should yet be patient. One of the most important things that he should remember is that whatever new ideas he puts forward, he should be doing this *with*, not *to* others. His new suggestions, indeed, should take cognizance of the fact that he is in India and that the usefulness of his suggestions can be measured only according to the Indian framework of reference. His thorough grasp of the fundamentals will enable him to face with

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confidence problems which are different in their outward appearance, yet alike in fundamentals to the ones he has acquired the tools with which to solve.

If the young engineer's approach is right and his attitudes are correct, it will not be difficult to melt all ice of prejudice and establish in its place a garden of hope and faith. He can open new eras of glorious tomorrows by introducing new techniques. His will then be the satisfaction of having given measurable help in building up a nation both technologically and economically.

A foreign-trained engineer can serve one other great cause. As he has had the rare opportunity of having lived, for a considerable length of time, in a wholly different country and amongst different people than his own, he is in a position to make the two nations and their peoples more understandable to each other, for what the world needs today is understanding. One people may not agree with another, but it is absolutely imperative that they understand each other; for that is what will make them more tolerant towards each other, and more appreciative of each other's merits. The Western-trained engineer from the East can help bridge the gap between the East and the West which snarls at us today.

The example considered above of an Indian engineer who is trained in the United States has many a counterpart in a great many other countries in numerous cases. Formerly nations have given financial, economic, military and other kinds of aid without any regard to the fact that any such aid is interconnected, whether we want it or not, with the human problems in the nation aided. Some of the results that such thoughtless aids have brought have been most disastrous. It has only recently been recognized that no amount of economic or military aid to any nation will really solve its problems unless such aid is carefully complemented with measures which take simultaneous cognizance of the human problems involved.

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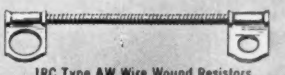

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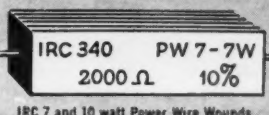

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turning over a new wheel

By Karl E. Ludvigsen, '56

Uncle Karl Drives the Porsche, Panhard and Studebaker

Engineers all over the world will admit that American cars are in a class by themselves when judged by engineering effort per pound, but this effort is often diverted into channels that lead far from the automobile itself. In Europe, where one man may be responsible for the design of an entire car, and where limited production allows facile and frequent design alterations, engineers have probed into relatively untested regions and have come up with remarkable and efficient designs that point the way for future endeavors. Two such cars, the familiar Porsche and the less common Dyna Panhard Junior, recently passed through our hands, and we would like to give details and impressions of them here.

The Porsche concern of Stuttgart is now headed by the son of the late Dr. Porsche, and functions primarily as a consulting engineering firm. They do, however, build a sports car which has become very popular in the United States. The Porsche car took shape in the mind of one of the greatest automotive engineers we have ever known, and is built by hand by a small group of Germany's best craftsmen. A pressed steel platform utilizing box sections is the basis of the car, and the engine and drive system are located at the rear. The power plant is a flat opposed four cylinder unit, available in sizes up to 1500 cubic centimeters, and featuring an "over-square" bore-stroke ratio. The pushrod-operated overhead valves open into a hemispherical combustion chamber. Air cooling is employed, and the deeply-finned cylinders are shrouded to direct the air from the large blower mounted atop the engine. The cylinder walls are unusual in that there is no steel liner, but rather the aluminum walls are directly chromium-plated and specially knurled to retain oil. The engine is behind and the gearbox is ahead of the rear axle, the differential housing being in unit with these and bolted to the frame. Rear suspension is by swing axles while trailing arms are used at the front, torsion bars being the elastic medium in both cases. This system gives a roll center above the axle in the rear and at ground level in the front. The body-work is of the highest quality, and the lines of the car are extremely functional in a very attractive way.

This very rare and handsome factory-built Porsche roadster was once the property of Bill Lloyd.

The engineering excellence of the Porsche gives promise of interesting qualities on the road, and this promise is fulfilled. The separate front seats are well formed to keep the driver in place and erect. The relatively small steering wheel is not adjustible but is at a good angle, and the conveniently placed floor gear lever is remarkably precise in consideration of its distance from the gearbox. The running of the engine cannot be described as smooth or silent, but the unit gives a feeling of remarkable torque at low speeds for its size that is later borne out. The first impression of the car on the road concerns its remarkably light and precise steering. It is only necessary to "wish" the car in a certain direction to have it respond quickly and accurately. The brakes were also impressive, the car seeming to crouch down and cling when they were applied. The car tested was a 1952 model and thus lacked the very good synchromesh system later developed by the Porsche works. The "crash" type box was a great deal of fun, but when one is in a hurry synchromesh is appreciated. As in all small-engined cars, the Porsche gearbox demands full use for best performance, and when this is done there are few

The Studebaker has excellent vision and trim lines in the rear.

cars that can pass it by at any speed. The remarkable suspension allows the most winding of roads to be negotiated at very high speeds, once the unique characteristics of rear engine and swing axle springing are mastered. On the other hand, the overdrive on fourth gear and the very short stroke engine produce a car that is supremely happy on the fastest of American toll roads. The driver enjoys a fine ride and vision over the low, broad hood that is second to none. Dr. Porsche's creation thus comes very close to being the ideal sports car for the American continent, and these qualities combined with its excellent economy of operation have made it a frequent sight in that area.

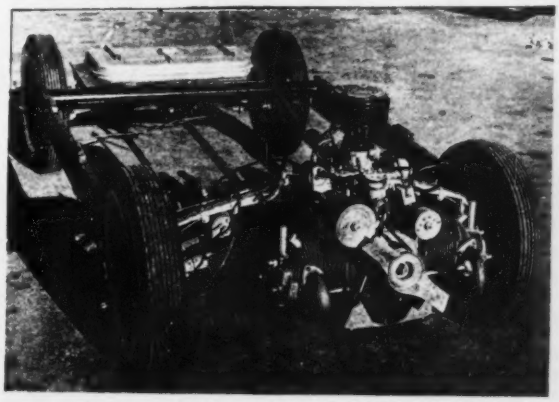
The smooth lines and air cooling ducts of the Porsche are easily seen here.

The French Dyna Panhard Junior is built by the firm of Panhard and Levassor, one of the oldest automotive producers in the world. By this standard, it might be expected to be a conservative car that had never risked public disapproval by unconventional design features. The Dyna, however, is one of the most unusual cars to be found anywhere in the world. There are at present but a handful in the United States, but the importers are currently considering a more extensive invasion. It is much like the Porsche, and yet much different from it. It has a flat opposed air cooled engine, with all drive components in one unit, but the engine has only two cylinders, and is placed in the front of the car, front wheel drive being employed. The 610 cubic centimeter power plant nestles just behind the front bumper, the following units in a rearward direction being the clutch, the four-speed non-synchromesh gearbox, the final drive unit, and the occupant's feet. This arrangement produces a larger-than-ordinary overhang at the front, and allows a very short wheelbase. The engine is a mass-production unit, but the rest of the car is very much special, save the dashboard and the rear suspension assembly. These components are all attached to a very light shell structure of steel sheet and tubing, which forms both chassis and body. The latter has a brutally simple shape, with a squarish nose and tapered tail, giving good aerodynamics particularly with the very effective top and side curtains erected. The interior is austerely finished in leatherette, but there is room for three passengers, and there is a wealth of luggage capacity behind the seat. Legroom is a bit inadequate for the tall driver, and the gear lever *hangs down* from under the dashboard.

The Panhard has about the same valve arrangement as the Porsche, except that torsion bar valve springs are employed. The aluminum-finned cylinders have steel liners, and no ducting of any kind is used from the two-bladed fan at the front of the car. Roller main and connecting rod bearings allow the engine to turn up over 5000 revolutions per minute, at which speed it develops 28 horsepower. The front drive operates through two splined and universally-jointed shafts that pass to the wheels between the two transverse leaf springs that comprise the front suspension. The rear wheels are attached to a solid axle which is nevertheless cleverly pivoted and sprung by torsion bars to give a semblance of independence. The front springs are very stiff, while those at the back are soft but well damped, since the rear wheels must act rather like a trailer. Steering is by rack and pinion, and has about the same ratio as the M.G. TD.

The car is started in much the same way as a motorcycle, and a hand spark advance is provided on the dash for this purpose. Once warmed up, the engine idles with impressive slowness, and shows a welcome willingness to "rev". The gear ratios are well chosen, and the size of the gears makes shifting simple in spite of the lack of help from the transmission. Acceleration is creditable for the engine size, and a useful third (good up to 60 miles per hour) and an overdrive fourth make a very capable highway car. The true top speed was between 70 and 75, and a cruising speed of 65 was well within the car's limits. At lower speeds, of course, the engine cannot be described as smooth, but when it gets into its stride those two cylinders go to work in a very effective manner. The car tested had done about 13,000 miles, and at that distance the gears were very noisy, with a particularly annoying howl in top at medium speeds. Front wheel drive produces a

The Panhard engine location is unusual but effective for an air-cooled unit.



car with unusual handling qualities, and we are certain that, properly driven, a Dyna Junior will corner with the very best. The steering is quick, though a trifle heavy, and with the car aimed in the right direction, the power full on, and traction

(Continued on page 46)

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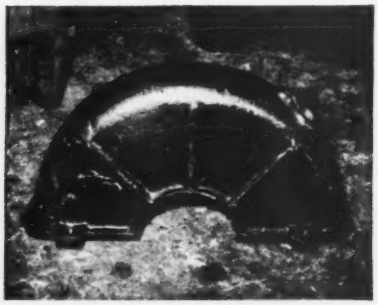

Fig. 1. Original construction *of gear case cover weighed 66 pounds . . . required milling of bottom edge for oil-tight seal with gear case.*

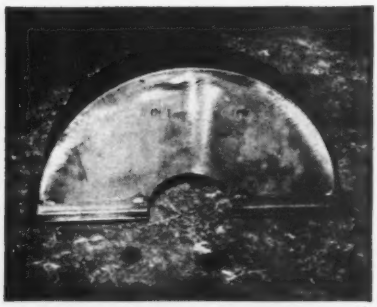

Fig. 2. Steel designed gear case *cover now used weighs only 10 pounds . . . costs half as much to produce. Fabricated entirely in the manufacturer's own shop by arc welding.*

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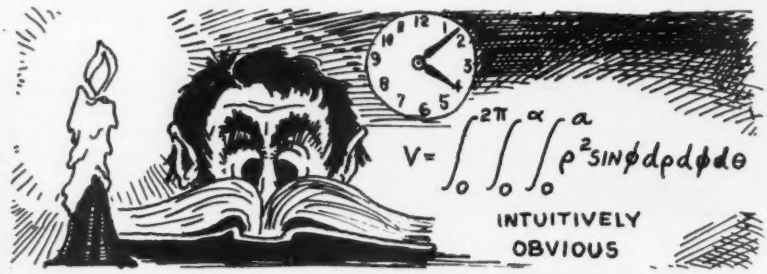
how to write a text book

(By an anonymous M. I. T. professor)

In writing a textbook, one must first choose a subject which is straight-forward and not very complicated; in short, a subject in which there is far too little confusion among students. Next, consider the practical applications of the subject and determine the page on which you will refer to them with a footnote. Then take the remaining material and sort it at random into twenty-five buckets. Call each bucketful a chapter.

Use Impressive Titles

Make the title of each chapter as impressive as possible. (You can really wow 'em with a big, hairy title. Bessel's Functions is a good one—it would even frighten a school girl of four.) Organize the material of each chapter in such a way that you cut down the number of sections, paragraphs, and equations to about twice what is necessary. Assign each equation a simple reference number; such as the first number of the corresponding page of the telephone book. Another thing, never write down an equation without referring back to at least five or six others.



Equations are of Theoretical Interest Only

The equations on each chapter should gradually lead up to one fundamental equation. Give the name of the fellow who derived it, and end each chapter by saying, "This fundamental equation is of theoretical interest only, as we shall see in a later chapter." In this later chapter, you derive another fundamental equation and say, "Of course this reduces to the equation of the previous chapter for the trivial case. More complicated cases are beyond the scope of this book." (One can avoid the boring repetition of this phrase by saying "—will be found in—" and give a reference.

As for the derivations themselves, if you cannot locate a proof less than a page long, say "This can easily be shown." When you can find no proof whatsoever, write, "It is intuitively obvious," or, "Brief consideration will demonstrate." In the course of your derivations, leave out as many steps as possible. Use the steps, which have been left out as problems for the end of the chapter. Diagrams should always be drawn using three coordinate axes, three rotated axes, and twelve reference angles. Use Greek letters at all times, especially groups of them which rhyme, like beta, zeta, eta, and theta, or xi, pi, phi, chi, and psi. The students will be charmed by the poetic quality of these combinations.

At the end of the last chapter, write an apologetic paragraph which should run something like this: "This text is by no means complete. If we have left out anything, it is not because we have attempted to avoid mathematical analysis, but because we deeply hope that the reader wishes to look in other sources for further material." You might casually mention that the last work on the subject will be found in your other book. (There are exceptions to this type of ending. One of my colleagues, for instance, has closed with the stirring words, "The factor 2 is introduced because the cylinder intersects the sphere below as well as above the xy-plane.")

To many people, Grinnell is known best as a producer of high quality malleable and cast iron pipe fittings or perhaps as the manufacturer of Grinnell Automatic Sprinkler Systems. But there are other reasons behind Grinnell's leadership in the piping field. For example . . .

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briefing the news

Electronic Translation

Russian was translated into English by an electronic "brain" recently for the first time.

Brief statements about politics, law, mathematics, chemistry, metallurgy, communications and military affairs were submitted in Russian by linguists of the Georgetown University Institute of Languages and Linguistics to the famous 701 computer of the International Business Machines Corporation. And the giant computer, within a few seconds, turned the sentences into easily readable English.

A girl who didn't understand a word of the language of the Soviets punched out the Russian messages on IBM cards. The "brain" dashed off its English translations on an automatic printer at the breakneck speed of two and a half lines per second.

"Mi pyeryedayem mislyi posryedstvom ryechyi," the girl punched. And the 701 responded: "We transmit thought by means of speech."

"Vyelyichyina ugla opryedyelyayetsya otnoshyenyiyem dlyini dugi k radyiusu," the punch rattled. The "brain" came back: "Magnitude of angle is determined by the relation of length of arc to radius."

More than sixty Russian sentences were given to the "brain" altogether. All were translated smoothly in the demonstration performed jointly by Georgetown and IBM.

A handful of men had been individually engaged in research at various institutions for almost a decade to make a machine convert the meaning of words clearly from one language to another. No practical results were achieved until Georgetown a year and a half ago enlisted the aid of the most versatile electronic "brain" extant, the IBM 701.

This instrument was interrupted in its 16-hour-a-day schedule of solving problems in nuclear physics, rocket trajectories, weather forecasting and other mathematical wizardry. Its attention was turned at brief intervals from these lightning-like numerical calculations to the altogether different consideration of logic in an entirely new and strange realm for giant electronic data processing machines: the study of human behavior—specifically, the human use of words.

So far as IBM's big 701 was concerned, today's demonstration could have been carried out with English and any one of a number of languages. Russian was chosen by the Georgetown linguist because present-day understanding of the Soviet by western countries is impeded by the relatively small number of students of Russian as opposed to a steadily growing accumulation of Russian textual material whose true significance cannot even be estimated until its content can be converted into English. They chose scientific and technical subjects as their first source because that type of writing is done with words having highly specialized meanings, and it is possible to predict that if a word appears in a certain context the chances of its having a certain meaning are extremely high.

The same probabilities of accurate prediction occur in other fields of technical writing, such as medicine and engineering. Consequently, Doctor Dostert assumes that electronic translation will begin with separate dictionaries for each technical area, and that as experience with them grows, enough will be learned to permit accurate translation of our common everyday language, in which are such illogical and unpredictable words as "charleyhorse."

What the electronic translators have actually done is to create an entirely new electronic language. They have taken normal words and attached to them tags or signs which give each word a precision it does not usually possess. These signs actually denote rules of grammar and meaning. Although only six rules were used during the demonstration, the six were enough to cover all the words in all the sentences the 701 was asked to translate. The "brain" could translate only because these rule-tags were hitched onto normal words, for it cannot think independently. It can only perform tasks in obedience to detailed instructions prepared by human minds. And the minds of the Georgetown linguists could not give the "brain" dependable instructions until they themselves had worked out foolproof means of telling in advance how to translate a word which had more than one meaning.

The six rule-tags were the solution. Those particular six were chosen because they have a broader effect on language translation than any other rules studied by the Georgetown linguists. Doctor Dostert estimates that it may take as many as one hundred rule-tags to translate scientific and technical literature in general. But, no matter how large the number becomes the six will remain basic. The six rules govern transposition of words where that is required in order to make sense, choice of meanings where a word has more than one interpretation, omission of words that are not required for a correct translation, and insertion of words that are required to make sense.

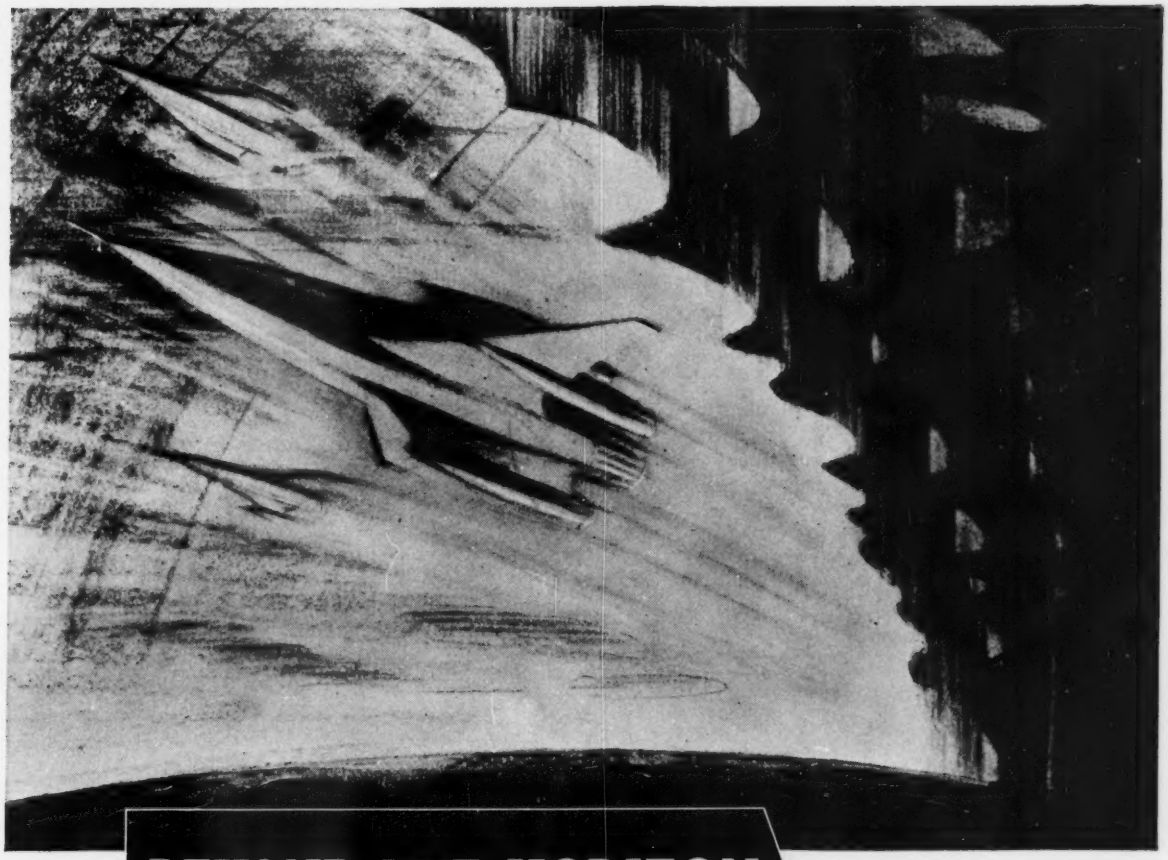
Here is an explanation of the mechanics involved in the operation of one rule which governs transposition of words where such inversion is required in order to make sense.

We begin with the Russian *gyeneral mayor.* These two words must be reversed to arrive at the proper translation in English: *major general.*

The switch is assured in advance by attaching the rule sign 21 to the Russian *gyeneral* in the bilingual glossary which is stored in the machine, and by attaching the rule-sign 110 to the Russian *mayor.*

The stored instructions, along with the glossary, say "whenever you read a rule-sign 110 in the glossary, go back and look for a rule-sign 21. If you find a 21, print the two words that follow it in reverse order."

So the instant the "brain" is given *gyeneral mayor* to translate, it looks in the glossary, finds the two words there, reads the rule-sign 110, goes back and finds rule-sign 21, and automatically acts accordingly—all in the twinkle of an eye.



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"Appreciating the fact that someone must fill these jobs, our management is striving to develop capable leadership among the younger men of the corporation.

"As a prospective Worthington Sales Engineer, I received several months of classroom instruction by works managers, top sales personnel and application engineers at all of the Worthington plants. The background I obtained was a sound basis for further development and learning gained in one of the product sales divisions and then in a district sales office. After obtaining sufficient product knowledge and sales training, I was ready to sell directly to industry. As more important sales assignments are available, I feel I will progress in proportion to my own development and sales performance.

"As a Worthington salesman I contact a class of trade with which it is a pleasure to do business. The company's reputation is a key to a welcome reception by my customers.

"I have found that with Worthington you have job satisfaction, adequate compensation, and unlimited opportunity."

When you're thinking of a good job, think *high*—think *Worthington.* 3.6

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

THE DU PONT DIGEST

Technical Sales

A major in glibness and a minor in solid information—those were the mythical requirements for a salesman in the old days. But they really never sufficed for a man selling the products of chemical technology.

Today, the diverse applications of Du Pont's 1200 products and product lines create a need for trained sales personnel representing many different technical backgrounds. These men must deal intelligently with problems in chemistry and engineering applied to such fields as plastics, ceramics, textiles, and many others.

Du Pont technical men are assigned to various types of technical sales activity. In some spots they are equipped to handle all phases of selling. In others they deal mainly with customer problems. Also, certain departments maintain sales development sections, where technical problems connected with the introduction of a new product, or a new application for an established product, are worked out.

For example, a technical man in one of Du Pont's sales groups was recently called upon to help a customer make a better and less expensive hose for car radiators. Involved were problems in compounding, such as choice and amount of neoprene, inert fillers, softeners, accelerators, and antioxidants. Correct processing methods also had to be worked out, including optimum time and temperature of milling and extruding. The successful completion of this project naturally gave a good deal of satisfaction to the customer as well as Du Pont.

In another case a customer wanted to reduce carbon contamination of arc welding rod stock. A Du Pont technical service man suggested changes in cleaning procedures that lowered contamination by 90 per cent. The new process also reduced metal loss during heat treatment—a benefit that more than offset the cost of the additional cleaning operations.

Technical men interested in sales work usually start in a laboratory or manufacturing plant where they can acquire needed background. Depending on their interest and abilities, they may then move into technical sales service, sales development, or direct sales.

In any of these fields, the man with the right combination of sales aptitude and technical knowledge will find interesting work, and exceptional opportunities for growth in the Du Pont Company.

W. A. Hawkins (*left*), B.S.M.E., Carnegie Tech., demonstrates extrusion of "Teflon" tetrafluoroethylene resin for a customer.

James A. Newman, B.S. in Ch.E., North Carolina State (*left*), discusses study of optimum settings and conditions for carding nylon staple with Prof. J. F. Bogdan of North Carolina State's Research Division.

ASK FOR "Chemical Engineers at DuPont." This new illustrated booklet describes initial assignments, training, and paths of promotion. Just send a post card to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware. Also available: "Du Pont Company and the College Graduate" and "Mechanical Engineers at Du Pont."

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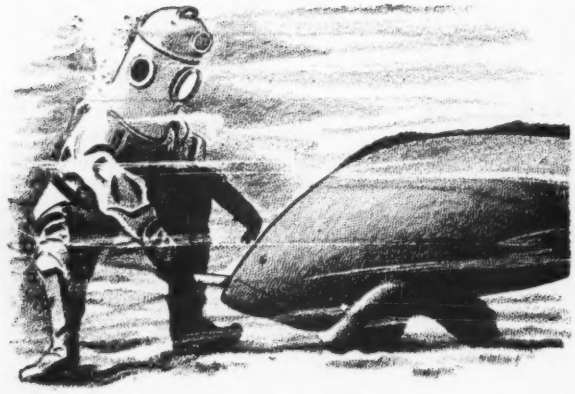

The wonders of the ocean's floor are duplicated in two giant tanks at Marine Studios, at Marineland, Fla. More than 30,000 live undersea specimens are presented in their natural setting, and into these tanks are pumped more than 7,000,000 gallons of sea water per day.

Okolite-Okoprene cable was selected as the most reliable means of supplying power to the motors which pump this water. Power is taken from a 2300-volt circuit and stepped down to 220-110 volts, for motors ranging from ¼ to 30 h.p.

The corrosive influence of salt water and salt air has virtually no effect on the tough Okoprene sheath which protects Okolite-Okoprene cable.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE insulated wires and cables

8785

a new wheel

(Continued from page 39)

for the front wheels, it seems capable of anything. There is no perceptible roll during such manoeuvres, and yet the Dyna rides much better than the popular M.G. Considerable driving was done on slippery and icy roads, under which conditions we had much more control than in any other car we had driven. No direct measure was taken of economy, but the car used about a dollar's worth of Ethyl during several days' active driving. Panhard's engineers succeeded well in producing a remarkably fast car for its size through design innovations and intelligent weight reduction.

The mid-year vacation afforded us a chance to drive one of the new Studebaker Starliner coupes for over 600 miles, and we would like to give our impressions of the car here. This particular vehicle was a 1953 model, a Commander V-eight with the Automatic Drive. Studebaker and Raymond Loewy have been long and deservedly lauded for the sleek and rakish styling of this car, and few will contest that this car is one of the handsomest America has ever produced. How this styling works out in practice, however, was our concern during our turn at the wheel. Vision, of course, is excellent. We were able to see the ground about a yard in front of the car, and there were no serious blind spots. The driving position is very pleasant at first to someone used to relatively low foreign cars, and legroom is adequate for the long-legged driver. However, over a long distance, a few faults show up. The seat has the feeling of being canted more to the front than usual, and this may have been done to provide steering wheel clearance in the exceptionally low design. Also, the instrument panel, while highly decorative, was difficult to read rapidly at turnpike speeds and featured a very awkward placing of the otherwise satisfactory toggle switches.

Enthusiasts often question the handling qualities of these cars, and it can be answered that the low center of gravity and relatively good weight distribution give a car that is a pleasure to drive on American highways and toll roads. We were consistently able to exceed the speeds of other cars on curves and pike entrys without incurring tire squeal. The latter will be heard much before the car begins to lean appreciably, and both take place at relatively high speeds. The steering retains a typically American ratio, but it has the virtues of directness and lightness. The ride is not spectacular by Detroit standards, but it was completely satisfactory save under very special conditions. A rough stretch of concrete set up sufficient rear axle vibration to cause us to stop and check the tires. The overall constructional standard of the body cannot be described as high. The hood and trunk lid were not braced, and while they are doubtless light, they are very flimsy. This impression, unfortunately, was general. The engine and running gear, however, were quiet and seemingly sound. Studebaker's new V-eight was designed with larger than usual safety and longetivity factors, and it is a responsive and efficient power plant. The Automatic Drive seemed to be set up for maximum economy of operation. It is possible to control the one shift point by accelerator pressure, but a prodigious lead foot is required to make this take place much above twenty miles per hour. This is not the case with the very similar Ford transmission, which has several desirable features, but which does not have the direct drive high. While annoying at times, this setting paid off, the gasoline mileage on the trip being closer to twenty than to fifteen miles per gallon. 120 horsepower doesn't count for much among today's high-powered behemoths, but the light weight and efficiency of the Studebaker design allow it to be put to work in a pleasingly potent manner. The car accelerates quickly and effectively from all speeds, given the proper functioning of the Automatic Drive, and is capable of cruising at high road speeds without distress. When the engine was idling normally there was no "creep" whatsoever at traffic lights, thanks to an exclusive Studebaker feature.

To sum up, then, the styling is wonderful, but there are a few penalties in convenience. The light construction gives a responsive and economical car, but leaves an impression of flimsiness. The engine and drive are more than satisfactory when correctly operated Handling qualities do not come close to making the Studebaker a sports car, but for the driver who wants more than the normal degree of stability while driving rapidly on American roads the Starliner is ideal.

HOW HERCULES HELPS...

Hercules' business today helps almost everyone's business. It embraces the production of synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products, and many other chemical processing materials—as well as explosives. Through close cooperative research with its customers, Hercules has helped improve the processing or performance of many products.

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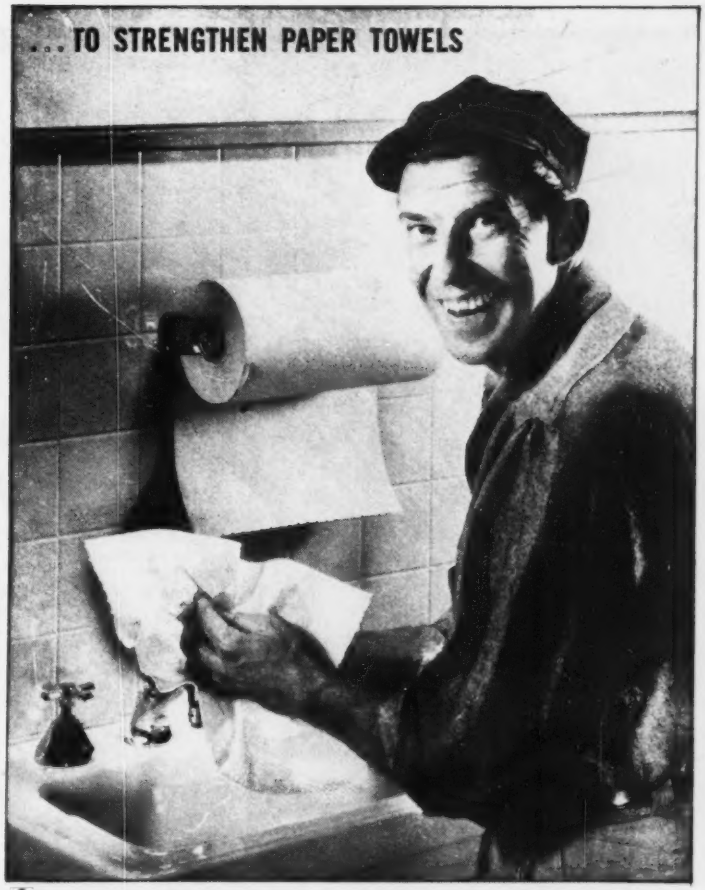

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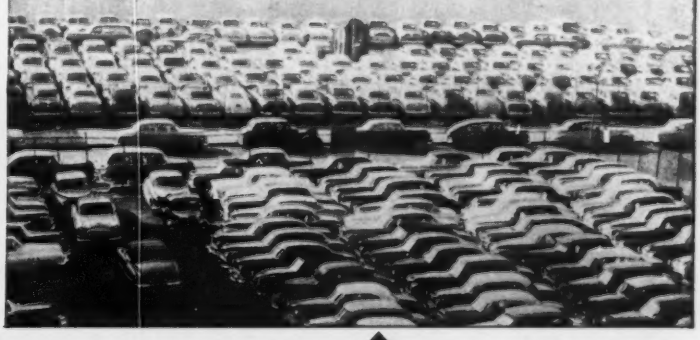

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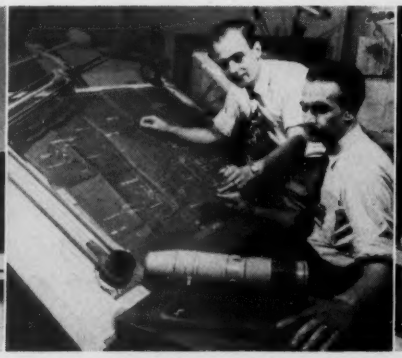
RESEARCH—World famous for its achievements in both pure and applied science, G-E research is led by scientists whose names are known everywhere. The many Company laboratories cover a wide range of scientific investigations. Research activities include physics, chemistry, metallurgy, mechanical and electrical problems, ceramics, and many other fields.

Sound engineering is one of the foundation stones of General Electric's leadership in the electrical industry. The importance of the role of the engineer has been recognized from the very beginning of the Company. Since 1892, G.E.'s Engineering Program—the oldest on-the-job training program in industry—has been affording young engineers widespread opportunities for professional development.

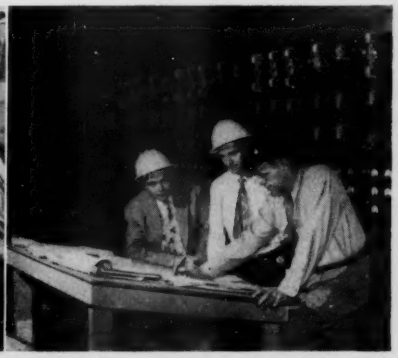
Besides the engineering fields briefly described here, career opportunities with a bright future are waiting for engineers in other important fields at General Electric . . . in manufacturing engineering . . . sales engineering . . . installation and service engineering . . . advertising . . . administration . . . other specialties in engineering.

If you are an engineer interested in building a career with an expanding and ever-growing Company see your college placement director for the next visit of the G-E representative on your campus. Meanwhile, for further information on opportunities with G.E., write to College Editor, Dept. 2–123, General Electric Co., Schenectady 5, N. Y.

DEVELOPMENT ENGINEERING—Development engineers are continually obtaining and assessing new basic engineering and scientific knowledge to make possible new developments. They serve as consultants to help in the solutions of engineering problems, which often require research, experimentation, and the development of a new product or component.



DESIGN ENGINEERING—To maintain leadership in the electrical field, design engineers are constantly striving to develop new and better products. Their skill is largely responsible for the steam and gas turbines, motors, heat pump, control equipment, and many other products. In electronics, they design equipment for television broadcasting and reception, radar, and other electronic equipment.



APPLICATION ENGINEERING—Since much equipment today is designed for a specific use, the application engineer must have a broad knowledge of the industry for which a particular product is being designed. Because G-E products are widely used throughout industry, imagination, determination, and a sound knowledge of engineering are important assets in this ever-growing field.

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